New Jersey Department of Environmental Protection
Division of Water Monitoring, Standards and Pesticide Control
Bureau of Environmental Analysis, Restoration and Standards

Basis and Background for Criteria Derivation and Practical Quantitation Levels

Ground Water Quality Standards Rule Amendments N.J.A.C. 7:9C

New Jersey Department of Environmental Protection

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Basis and Background for Criteria Derivation and Practical Quantitation Levels for Proposed Amendments to the Ground Water Quality Standards Rules, N.J.A.C. 7:9C

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1. Introduction

This Basis and Background document is limited to the currently proposed amendments to the Ground Water Quality Standards (GWQS), N.J.A.C. 7:9C (see 56 N.J.R. 3(a)). The proposed amendments would update the health-based specific ground water quality criteria and/or practical quantitation levels (PQLs) for 72 constituents in Appendix Table 1 of the rules, resulting in changes to the ground water quality standards for 63 constituents.

In addition, the New Jersey Department of Environmental Protection (Department) is proposing to add language under N.J.A.C. 7:9C-1.7(c)3i to enable the Department to update the specific ground water quality criterion for a constituent with a corresponding Maximum Contaminant Level (MCL) in the Safe Drinking Water Act (SDWA) rules, N.J.A.C. 7:10, when the Department determines that the weight of evidence approach specified at N.J.A.C. 7:9C-1.7(c)3ii would more appropriately address the risk posed by the constituent than the risk addressed by the health-based level used to establish the MCL. The proposed amendments also revise the default values for body weight and drinking water consumption rate at N.J.A.C. 7:9C-1.7(c)4i and ii to be consistent with the United States Environmental Protection Agency (USEPA) Final Updated Ambient Water Quality Criteria for the Protection of Human Health (EPA-HQ-OW-2014-0135; FRL-9929-85-OW) published in the Federal Register on June 29, 2015. Finally, the proposed amendments revise N.J.A.C. 7:9C-1.7(c)4iii and -1.9(c)3i to round new or revised criteria and PQLs to two significant figures, if scientifically supportable, and one significant figure otherwise, to be consistent with the rounding protocols employed for other environmental standards promulgated by the Department.

2. Background

Ground water quality standards are necessary to achieve the policy of the New Jersey Water Pollution Control Act, which is "to restore, enhance and maintain the chemical, physical, and biological integrity of [the State's] waters, to protect public health, to safeguard fish and aquatic life and scenic and ecological values, and to enhance the domestic, municipal, recreational, industrial and other uses of water" (N.J.S.A. 58:10A-2). Under the Ground Water Quality Standards, N.J.A.C. 7:9C, the Department designates ground water classifications throughout the State, assigns designated uses of the ground water within each classification, and establishes water quality criteria to support those designated uses.

The Department uses ground water quality standards to protect pristine aquifers, set standards for discharges to ground water under the New Jersey Pollutant Discharge Elimination System (NJPDES) program, establish standards for ground water remediation under the Contaminated Site Remediation and Redevelopment Program (CSRRP), and implement other requirements and regulatory actions applicable to discharges that cause or may cause pollutants to enter the

ground waters of the State, including nonpoint and diffuse sources regulated by the Department. Other relevant laws through which the ground water quality standards may be applied include, but are not limited to, the Spill Compensation and Control Act (N.J.S.A. 58:10-23.11 et seq.), the Brownfield and Contaminated Site Remediation Act (N.J.S.A. 58:10B-1 et seq.), the Site Remediation Reform Act (N.J.S.A. 58:10C-1 et seq.), the Solid Waste Management Act (N.J.S.A. 13:1E-1 et seq.), the Industrial Site Recovery Act (N.J.S.A. 13:1K-6 et seq.), the Underground Storage of Hazardous Substances Act (N.J.S.A. 58:10A-21 et seq.), the Realty Improvement Sewerage and Facilities Act (N.J.S.A. 58:11-23 et seq.), and the Pesticide Control Act of 1971 (N.J.S.A. 13:1F-1 et seq.).

Ground water quality standards (or constituent standards) are the maximum levels or concentrations of constituents allowed in each classification area, as established in N.J.A.C. 7:9C-1.7, 1.8 and 1.9(a) and (b). There are three major classes of ground water, as defined in N.J.A.C. 7:9C-1.5: "Class I Ground Water of Special Ecological Significance" (Class I), "Class II Ground Water for Potable Water Supply" (Class II), and "Class III Ground Water With Uses Other Than Potable Water Supply" (Class III). Each of these three classes of ground water contains subclasses based on the different primary and secondary designated uses of the ground water therein. In accordance with N.J.A.C. 7:9C-1.9(c), the ground water quality standard for a particular constituent is the applicable ground water quality criterion established under N.J.A.C. 7:9C-1.7 based on the ground water classification and adjusted by the applicable antidegradation policy for that classification established under N.J.A.C. 7:9C-1.8 and any applicable criteria exceptions provided under N.J.A.C. 7:9C-1.9. These standards serve as the basis for the Department's regulation of ground water quality effects of past, present or future discharges to ground water or the land surface as authorized under N.J.A.C. 7:9C-1.1.

The ground water quality standard for each constituent in Class II-A ground water is based on the numeric ground water quality criterion derived from the best available toxicological information to ensure adequate protection of human health and the PQL selected or derived to reflect analytical constraints on measuring the constituent concentration in ground water. Ground water quality criteria for Class II-A ground water are the levels or concentrations of constituents that, when exceeded, will prohibit or significantly impair use as potable water (that is, drinking water). There are three types of ground water quality criteria for constituents in Class II-A ground waters:

1. "Specific" ground water quality criteria are those listed for each constituent in Appendix Table 1 of the Ground Water Quality Standards.

2. "Interim specific" ground water quality criteria are those established by the Department following procedures set forth in the Ground Water Quality Standards, pending adoption via formal rulemaking of specific criteria for those constituents into Appendix Table 1. Interim specific criteria are derived where sufficient information is available to determine the human

health risk and derive an appropriate toxicity factor. This is done to assure that public health and the environment are protected in the most expeditious fashion once a concern is identified, usually in response to remediation of a contaminated site.

3. "Interim generic" ground water quality criteria are those listed in Appendix Table 2 of the Ground Water Quality Standards and applied to Synthetic Organic Chemicals (SOCs) without a specific or interim specific ground water quality criterion, depending on whether or not there is evidence for carcinogenicity and the number of SOCs present at a given site.

Since Class II-A ground water quality criteria are human health-based, they may be set at a concentration that is below the lowest concentration that is measurable using approved analytical methods. In these circumstances, the Department uses PQLs to determine compliance with the health-based criteria. The PQL is the lowest concentration of a constituent that can be reliably achieved among laboratories within specified limits of precision and accuracy during routine laboratory operating conditions. In accordance with N.J.A.C. 7:9C-1.9(c)3, the Department selects or derives PQLs that are as close to the health-based criterion as possible while achievable by the certified laboratory community. The ground water quality standard for each constituent in Class II-A ground water is the higher (less stringent) of the applicable ground water quality criterion and the PQL for that constituent.

The GWQS were readopted without change on March 1, 2021. With the exception of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) (adopted in 2020) and 23 former interim specific ground water quality criteria (adopted in 2018), the majority of the constituents listed in Appendix Table 1 "Specific Ground Water Quality Criteria - Class IIA and Practical Quantitation Levels" have remained unchanged since the readoption and recodification with amendments on November 7, 2005. Information about previous adoptions is available on the Department's website at http://www.nj.gov/dep/wms/bears/support_docs.htm#gwqs.

3. Summary of Proposed Amendments to the Ground Water Quality Standards, N.J.A.C. 7:9C

The existing specific ground water quality criteria, PQLs, and ground water quality standards for constituents in Class II-A ground waters (Appendix Table 1) were promulgated as part of the recodification and readoption of the rules with amendments in November 2005, except for the following: barium and toluene, which were established by notice in August 2007; the 23 interim specific criteria, PQLs and standards that were adopted as specific criteria, PQLs and standards in January 2018; criteria for 1,2,3-trichloropropane (TCP) and perfluorononanoic acid (PFNA) updated by notice in September 2018; and standards for PFOA and PFOS, adopted in 2020. The interim generic ground water quality criteria (Appendix Table 2) that existed at that time were also promulgated as part of the November 2005 rule readoption.

The Department is proposing to update the specific ground water quality criteria and/or PQLs, for 72 constituents in Appendix Table 1 of the rules based on updated human health data or improved analytical capabilities. These include updates to 53 ground water quality criteria and 38 PQLs. As stated above, a constituent's ground water quality standard is the higher of the PQL and the ground water quality criterion. The proposed updates will result in changes to the ground water quality standards for 63 of the 72 constituents. Of these 63 constituents, 49 will become more stringent, 12 will become less stringent, and two are new specific standards for constituents which currently have interim generic criteria. The two interim generic ground water quality criteria will be replaced with the proposed specific ground water quality criteria pursuant to N.J.A.C. 7:9C-1.7(c)3ii. The ground water quality standards for seven constituents: 1,1-biphenyl; cobalt; cyanide (free); 1,3-dichlorobenzene (meta); heptachlor epoxide; methoxychlor; and vinyl chloride will become more stringent by an order of magnitude or more and will trigger the "order of magnitude" provisions of the Brownfield and Contaminated Site Act, which may require additional remediation.

In addition, the Department is proposing to add language under N.J.A.C. 7:9C-1.7(c)3i that will enable it to update the specific ground water quality criterion for a constituent with a corresponding MCL in the SDWA rules, N.J.A.C. 7:10, when the Department determines that the "weight of evidence" approach specified at N.J.A.C. 7:9C-1.7(c)3ii would more appropriately address the risk posed by the constituent than the risk addressed by the health-based level used to establish the MCL. The Department is also proposing revisions to the default values for body weight and drinking water consumption rate at N.J.A.C. 7:9C-1.7(c)4i and ii to be consistent with the USEPA Final Updated Ambient Water Quality Criteria for the Protection of Human Health published in the Federal Register on June 29, 2015 at https://www.federalregister.gov/documents/2015/06/29/2015-15912/final-updated-ambient-water-quality-criteria-for-the-protection-of-human-health. The Department is also proposing amendments to the rounding provisions at N.J.A.C. 7:9C-1.7(c)4iii and -1.9(c)3i to round new or revised ground water quality criteria and PQLs to two significant figures when scientifically supportable and one significant figure otherwise.

This Basis and Background document explains the updates to the specific ground water quality criteria and PQLs in Appendix Table 1 of the rules. Explanations for the other proposed amendments are provided in the summary of the rule proposal published in the New Jersey Register and posted to the Department's website at www.nj.gov/dep/rules.

4. Updates to Ground Water Quality Criteria, PQLs, and Standards

The Department identified constituents from Appendix Table 1 for which updated human health data or improved analytical capabilities were available through 2017 and reevaluated the specific ground water quality criteria and PQLs for these constituents to ensure that they reflect the best

available science. The Department determined that sufficient information was available to update the criteria and/or PQLs for 72 constituents. As explained earlier, the ground water quality standard for each constituent is the higher of the applicable ground water quality criterion and the PQL. Therefore, updating the PQL or criterion for these constituents also resulted in a change to the ground water quality standard for 63 constituents. Of these 63 proposed ground water quality standards, 49 will become more stringent, 12 will become less stringent, and two are for constituents that currently have interim generic ground water quality criteria. The two interim generic criteria will be replaced with specific ground water quality criteria pursuant to N.J.A.C. 7:9C-1.7(c)3ii. The proposed standards for these two constituents will be less stringent than the current interim generic criteria. The proposed criteria updates for an additional nine constituents remain lower than their PQLs, resulting in no updates to the ground water quality standards for those constituents. The ground water quality standards for seven constituents: 1,1-biphenyl; cobalt; cyanide (free); 1,3-dichlorobenzene (meta); heptachlor epoxide; methoxychlor; and vinyl chloride will become more stringent by an order of magnitude or more and will trigger the "order of magnitude" provisions of the Brownfield and Contaminated Site Act, which may require additional remediation. Updated values are shown in Table A with larger font and bold type. Additional detail on individual constituents is provided below Table B.

Table A: Updates to Ground Water Quality Criteria (GWQC) and PQLs, Shown in Bold Type

Constituent	**CASRN**	**Existing Values (µg/L)**			**Proposed Values for Appendix Table 1 (µg/L)**		
		GWQC	**PQL**	**GWQS**	**GWQC**	**PQL**	**GWQS**
Acrolein	107-02-8	4	5	5	4	**4.4**	**4.4**
Acrylamide	79-06-1	0.008	0.2	0.2	**0.024**	0.2	0.2
Aldrin	309-00-2	0.002	0.04	0.04	0.002	**0.020**	**0.020**
Benz(a)anthracene	56-55-3	0.05	0.1	0.1	**0.1**	0.1	0.1
Benzene	71-43-2	0.2	1	1	**0.12**	**0.45**	**0.45**
Benzidine	92-87-5	0.0002	20	20	0.0002	**6.6**	**6.6**
Benzo(a)pyrene (BaP)	50-32-8	0.005	0.1	0.1	**0.01**	0.1	0.1
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	0.05	0.2	0.2	**0.1**	0.2	0.2
Benzo(k)fluoranthene	207-08-9	0.5	0.3	0.5	**1**	0.3	**1**
beta-BHC (beta-HCH)	319-85-7	0.02	0.04	0.04	0.02	**0.020**	**0.02**
1,1-Biphenyl (Diphenyl)	92-52-4	400	10	400	**4.1**	**5.0**	**5.0**
Bromodichloromethane (Dichlorobromomethane)	75-27-4	0.6	1	1	**0.98**	**0.50**	**0.98**

Constituent	**CASRN**	**Existing Values (µg/L)**			**Proposed Values for Appendix Table 1 (µg/L)**		
		GWQC	**PQL**	**GWQS**	**GWQC**	**PQL**	**GWQS**
Bromoform	75-25-2	4	0.8	4	**7.4**	0.8	**7.4**
Butyl benzyl phthalate	85-68-7	100	1	100	**18**	1	**18**
Cadmium	7440-43-9	4	0.5	4	**0.92**	0.5	**0.92**
Chlordane	57-74-9	0.01	0.5	0.5	0.01	**0.20**	**0.20**
4-Chloroaniline (p-Chloroaniline)	106-47-8	30	10	30	**0.18**	**5.0**	**5.0**
4-Chloro-3-methylphenol (3-methyl-4-chlorophenol)	**59-50-7**				**700**	**0.18**	**700**
Chlorpyrifos	2921-88-2	20	0.1	20	**7**	0.1	**7**
Chrysene	218-01-9	5	0.2	5	**10**	0.2	**10**
Cobalt	7440-48-4	100	0.5	100	**2**	**0.45**	**2**
Cyanide (free cyanide)	57-12-5	100	6	100	**4.2**	**5.0**	**5.0**
4,4'-DDE (Dichlorodiphenyldichloroethylene)	72-55-9	0.1	0.01	0.1	**0.20**	0.01	**0.20**
Dibenz(a,h)anthracene	53-70-3	0.005	0.3	0.3	**0.01**	0.3	0.3
Dibromochloromethane (Chlorodibromomethane)	124-48-1	0.4	1	1	**0.78**	**0.75**	**0.78**
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	0.02	0.02	0.02	**0.016**	0.02	0.02
1,2-Dichlorobenzene (ortho)	95-50-1	600	5	600	**210**	5	**210**
1,3-Dichlorobenzene (meta)	541-73-1	600	5	600	**4.7**	5	**5**
1,4-Dichlorobenzene (para)	106-46-7	75	5	75	**15**	5	**15**
3,3'-Dichlorobenzidine	91-94-1	0.08	30	30	0.08	**5.2**	**5.2**
1,1-Dichloroethane (1,1-DCA)	75-34-3	50	1	50	**22**	1	**22**
1,2-Dichloroethane	107-06-2	0.3	2	2	0.3	**0.060**	**0.3**

Constituent	CASRN	Existing Values (µg/L)			Proposed Values for Appendix Table 1 (µg/L)		
		GWQC	PQL	GWQS	GWQC	PQL	GWQS
1,1-Dichloroethylene (1,1-DCE)	75-35-4	1	1	1	**31**	1	**31**
cis-1,2-Dichloroethylene	156-59-2	70	1	70	**11**	1	**11**
1,2-Dichloropropane	78-87-5	0.5	1	1	**0.92**	**0.50**	**0.92**
1,3-Dichloropropene (cis- and trans-)	542-75-6	0.4	1	1	0.4	**0.45**	**0.45**
Dieldrin	60-57-1	0.002	0.03	0.03	0.002	**0.020**	**0.020**
Dimethyl phthalate	131-11-3				**20000**	**0.29**	**20000**
2,4-Dinitrophenol	51-28-5	10	40	40	10	**10**	**10**
2,4-Dinitrotoluene/2,6-Dinitrotoluene mixture	25321-14-6	0.05	10	10	0.05	**5.2**	**5.2**
Di-n-octyl phthalate	117-84-0	100	10	100	**80**	10	**80**
1,2-Diphenylhydrazine	122-66-7	0.04	20	20	0.04	**2.2**	**2.2**
Ethion	563-12-2	4	0.5	4	**3**	0.5	**3**
Ethylbenzene	100-41-4	700	2	700	**150**	2	**150**
Ethylene glycol	107-21-1	300	200	300	**5100**	200	**5100**
Heptachlor	76-44-8	0.008	0.05	0.05	**0.0081**	**0.020**	**0.020**
Heptachlor epoxide	1024-57-3	0.004	0.2	0.2	**0.0061**	**0.020**	**0.020**
Hexachlorobenzene	118-74-1	0.02	0.02	0.02	**0.033**	0.02	**0.033**
Hexachlorobutadiene	87-68-3	0.4	1	1	**0.8**	1	1
Hexachloroethane	67-72-1	2	7	7	**0.8**	**0.65**	**0.8**
Indeno(1,2,3-cd)pyrene	193-39-5	0.05	0.2	0.2	**0.1**	0.2	0.2
Methanol	67-56-1	4000	70	4000	**13000**	70	**13000**
Methoxychlor	72-43-5	40	0.1	40	**0.1**	0.1	**0.1**
Methyl ethyl ketone (MEK) (2-Butanone)	78-93-3	300	2	300	**4300**	2	**4300**
Methylene chloride	75-09-2	3	1	3	**6**	1	**6**
Nitrobenzene	98-95-3	4	6	6	**1.2**	**0.075**	**1.2**
N-Nitrosodi-n-propylamine	621-64-7	0.005	10	10	0.005	**1.6**	**1.6**
PCBs (Polychlorinated biphenyls)	1336-36-3	0.02	0.5	0.5	0.02	**0.20**	**0.20**
Pentachlorophenol	87-86-5	0.3	0.1	0.3	**0.08**	0.1	**0.1**
Perfluorononanoic acid (PFNA)	375-95-1	0.013	0.005	0.013	0.013	**0.0025**	0.013

Constituent	CASRN	Existing Values (µg/L)			Proposed Values for Appendix Table 1 (µg/L)		
		GWQC	PQL	GWQS	GWQC	PQL	GWQS
1,1,2,2-Tetrachloroethane	79-34-5	1	1	1	**0.2**	**0.065**	**0.2**
Tetrachloroethylene (PCE)	127-18-4	0.4	1	1	0.4	**0.055**	**0.4**
Tetrahydrofuran	109-99-9	10	10	10	**620**	10	**620**
Thallium (Total)	7440-28-0	0.5	2	2	0.5	**0.50**	**0.5**
Toxaphene	8001-35-2	0.03	2	2	0.03	**1.2**	**1.2**
1,2,4-Trichlorobenzene	120-82-1	9	1	9	**1.1**	1	**1.1**
1,1,1-Trichloroethane (TCA)	71-55-6	30	1	30	**1900**	1	**1900**
1,1,2-Trichloroethane	79-00-5	3	2	3	**0.58**	**0.24**	**0.58**
Trichloroethylene (TCE)	79-01-6	1	1	1	**0.28**	**0.10**	**0.28**
2,4,6-Trichlorophenol	88-06-2	1	20	20	**3.0**	**0.23**	**3.0**
1,2,3-Trichloropropane (TCP)	96-18-4	0.0005	0.03	0.03	0.0005	**0.0050**	**0.0050**
Vinyl chloride	75-01-4	0.08	1	1	**0.022**	**0.035**	**0.035**

4.1 Ground Water Quality Criteria Updates

The Department currently establishes interim specific and specific ground water quality criteria for Class II ground water constituents in two ways, pursuant to N.J.A.C. 7:9C-1.7(c)3i and ii.

1. If the Department promulgates in the Safe Drinking Water Act rules at N.J.A.C. 7:10 a maximum contaminant level (MCL) for a constituent, the health-based level used to establish the MCL shall be the specific ground water quality criterion for the constituent.

2. For all other constituents, the Department shall develop ground water quality criteria for Class II-A ground water based upon the weight of evidence available regarding each constituent's carcinogenicity, toxicity, public welfare or organoleptic effects, as appropriate for the protection of potable water.

The Department is proposing to add language under N.J.A.C. 7:9C-1.7(c)3i above to enable the Department to update the specific ground water quality criterion for a constituent with a corresponding MCL when the Department determines that the weight of evidence approach

specified at N.J.A.C. 7:9C-1.7(c)3ii would more appropriately address the risk posed by the constituent than the risk addressed by the health-based level used to establish the MCL.

For criteria derived pursuant to N.J.A.C. 7:9C-1.7(c)3ii and -1.7(c)4, the Ground Water Quality Standards describe the equations, data sources, default values, and conventions used by the Department when developing interim specific and specific ground water quality criteria for Class II constituents that don't have a promulgated MCL. A "default value" is a scientifically established value used in the development of criteria when contaminant-specific information is not available. The default values for adult body weight and drinking water consumption rate are being revised in these amendments to 80.0 kg and 2.4 liters/day respectively to be consistent with the 2015 USEPA Final Updated Ambient Water Quality Criteria for the Protection of Human Health. The Department determined that these default values for adult body weight and drinking water consumption rate are appropriate for use in deriving revised New Jersey criteria in the absence of New Jersey-specific data. Equations 1 and 2 below show the default equations at N.J.A.C 7:9C-1.7(c)4i and ii for deriving specific ground water quality criteria for Class II-A constituents and proposed new default values (in bold type).

Equation 1: Default equation used for the derivation of interim specific and specific ground water quality criteria for Class II-A constituents classified as carcinogens. All units noted below, except for the Upper Bound Lifetime Excess Cancer Risk of 1×10^{-6} which is unitless.

$$\text{Criterion } (\mu g/L) = \frac{\text{Upper Bound Lifetime Excess Cancer Risk} \times \text{Average Adult Weight} \times \text{Conversion Factor}}{\text{Carcinogenic Slope Factor} \times \text{Assumed Daily Water Consumption}}$$

Where the default values are:

Average Adult Weight	=	[70]**80.0** kg
Assumed Daily Water Consumption	=	[2]**2.4** liters per day
Upper Bound Lifetime Excess Cancer Risk	=	1×10^{-6}
Conversion Factor	=	1,000 µg/mg
Carcinogenic Slope Factor	=	Value from the United States Environmental Protection Agency (USEPA) Integrated Risk Information System (IRIS) data base, http://www.epa.gov/iris, incorporated herein by reference, as $(mg/kg/day)^{-1}$

Equation 2: Default equation used for the derivation of interim specific and specific ground water quality criteria for Class II-A constituents classified as non-carcinogens or carcinogens without a slope factor.

$$\text{Criterion } (\mu g/L) = \frac{\text{Reference Dose} \times \text{Average Adult Weight} \times \text{Conversion Factor} \times \text{Relative Source Contribution}}{\text{Assumed Daily Water Consumption} \times \text{Uncertainty Factor}}$$

Where the default values are:

Average Adult Weight	=	[70]**80.0** kg
Relative Source Contribution	=	20 percent
Assumed Daily Water Consumption	=	[2]**2.4** liters per day
Conversion Factor	=	1,000 µg/mg
Reference Dose	=	Value from the United States Environmental Protection Agency (USEPA) Integrated Risk Information System (IRIS) data base, http://www.epa.gov/iris, incorporated herein by reference, as mg/kg/day
Uncertainty Factor	=	10 for carcinogens for which no carcinogenic slope factor is applicable; 1 for non-carcinogens

The Department may, as appropriate, use alternative values or modified equations in the derivation of interim specific and specific ground water quality criteria to ensure that criteria reflect the best available science and adequately protect human health. Additional information on alternative values or modified equations used in the derivation of the ground water quality criteria covered by this proposal is included below and explained per constituent below Table B. Definitions of the terms used below are available at the USEPA's Integrated Risk Information System (IRIS) glossary

(https://sor.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&vocabName=IRIS%20Glossary).

For the current proposal, the Department reviewed data from the USEPA IRIS program's database through 2017. The IRIS database includes toxicity factors (that is, reference doses [RfDs] and cancer slope factors) and information on human health effects to provide consistent information on toxic substances for use by USEPA programs. IRIS assessments are an important source of toxicity information for states and other U.S. and international agencies; however, the Department recognizes that IRIS does not include the most current toxicity information or use the most current risk assessment approaches for all constituents. The Department has the flexibility to modify IRIS assessments, use assessments from sources other than IRIS, or derive toxicity factors itself for scientific reasons. For some constituents, the Department utilized toxicity factors from other sources, such as the New Jersey Drinking Water Quality Institute (NJDWQI), the USEPA Center for Public Health and Environmental Assessment (CPHEA) (formerly the National Center for Environmental Assessment [NCEA]) which develops Provisional Peer-Reviewed Toxicity Values (PPRTV), the USEPA Office of Water, California Environmental Protection Agency (CalEPA), and the Agency for Toxic Substances and Disease Registry (ATSDR) that were available through 2017. If there were toxicity data from multiple sources, the Department reviewed all available information and selected the most scientifically sound basis for ground water quality criteria development.

The Department generally follows risk assessment guidance provided by the USEPA in developing toxicity factors, including identification of the principal study and endpoint, identification of the point of departure (POD), and application of uncertainty factors (UFs) in RfD development. When developing an RfD for non-cancer effects of a contaminant, UFs are applied to the POD, which is either the lower confidence limit on the Benchmark Dose Limit (BMDL), the No Observed Adverse Effect Level (NOAEL), or the Lowest Observed Adverse Effect Level (LOAEL) identified from the principal study. The USEPA generally considers five possible UFs (USEPA 2002a). UFs are based on a logarithmic scale, and they can be either a factor of 10, 3 (10 raised to the half power = $10^{0.5}$ = 3.16 [which in practice is applied as a factor of 3]), or 1 (the UF is not applied). These five UFs account for the protection of sensitive human populations (that is, intraspecies variability); animal to human (that is, interspecies) extrapolation when the RfD is based on laboratory animal data; the duration of exposure (for example, for a study of shorter-than-chronic duration); the use of a LOAEL, NOAEL, or BMDL as a POD (for example, LOAEL-to-NOAEL extrapolation); and database deficiencies (for example, key data are lacking or available data indicates the potential for toxicity at doses below the POD). The selection of UFs is based on USEPA guidance and involves professional judgement. To derive the RfD, the selected UFs are multiplied together to yield a total UF that is applied to the POD (that is, the POD is divided by the total UF).

The derivation of some toxicity factors by some agencies, such as the U.S. Department of Health and Human Services' ATSDR, may not consider all five UFs. Additionally, an UF called a modifying

factor has been applied at times to account for uncertainties (for example, small sample size) not addressed by the standard UFs (USEPA 2002a). Further, the Department's policy stipulates that an additional UF of 10 be applied to the RfD for chemicals that are classified as Group C or suggestive human carcinogens when no cancer slope factor is available, or the available cancer slope is judged by the Department not to be technically sound (NJDEP 2004).

The USEPA recommends the application of age-dependent adjustment factors (ADAFs) for carcinogens with a mutagenic mode of action (MOA) when the exposure period includes early life, as is the case with chronic exposure to contaminants in ground water (USEPA 2005c). These factors are applied to account for the higher cancer risk from early life exposure to mutagenic carcinogens, as compared to exposure later in life. As described by the NJDWQI (2015), the USEPA recommends application of ADAFs for criteria based on drinking water exposure, such as ground water criteria, using the drinking water consumption assumptions for each age grouping (0 to less than 2 years old, 2 to less than 16 years old, 16 to 70 years old).

Table B lists the factors and sources that the Department used to derive the ground water quality criteria which are updated in this proposal. More detail on the derivations of these criteria is provided per constituent below Table B.

Table B: Factors Used to Derive Ground Water Quality Criteria

Constituent	CASRN	Oral RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)$^{-1}$	Carcinogenicity Classification	ADAF	RSC (%)	Proposed Criterion (µg/L)	Primary Basis for Proposed Revision
Acrylamide	79-06-1		0.52	Likely to be carcinogenic to humans[4]	Y		0.024	IRIS (USEPA 2010e)
Benz(a)anthracene	56-55-3		0.1	Probable human carcinogen (Group B2)[1]	Y		0.1	IRIS*
Benzene	71-43-2		0.28	Known human carcinogen[2]			0.12	NJDWQI (2009)
Benzo(a)pyrene (BaP)	50-32-8		1	Carcinogenic to humans[4]	Y		0.01	IRIS (USEPA 2017)
Benzo(b)fluoranthene (3,4- Benzofluoranthene)	205-99-2		0.1	Probable human carcinogen (Group B2)[1]	Y		0.1	IRIS*
Benzo(k)fluoranthene	207-08-9		0.01	Probable human carcinogen (Group B2)[1]	Y		1	IRIS*
1,1-Biphenyl (Diphenyl)	92-52-4		0.0082	Suggestive evidence of carcinogenic potential[4]			4.1	IRIS (USEPA 2013a)
Bromodichloromethane (Dichlorobromomethane)	75-27-4		0.034	Likely to be carcinogenic to humans by the oral route[3]			0.98	USEPA OW (USEPA 2005a)
Bromoform	75-25-2		0.0045	Likely to be carcinogenic to humans by all routes of exposure[3]			7.4	USEPA OW (USEPA 2005a)
Butyl benzyl phthalate	85-68-7		0.0019	Likely to be carcinogenic to humans[3]			18	NCEA PPRTV (USEPA 2002c)
Cadmium	7440-43-9	0.00011		As reported in USEPA (1989b), oral exposure studies in		25	0.92	ATSDR (2012)

Constituent	CASRN	Oral RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)$^{-1}$	Carcinogenicity Classification	ADAF	RSC (%)	Proposed Criterion (µg/L)	Primary Basis for Proposed Revision
				laboratory rodents provide no evidence of carcinogenicity				
4-Chloroaniline (p-Chloroaniline)	106-47-8		0.19	Likely to be carcinogenic to humans[4]			0.18	NCEA PPRTV (USEPA 2008c)
4-Chloro-3-methylphenol (3-methyl-4-chlorophenol)	59-50-7	0.1		Not classifiable as to human carcinogenicity (Class D)[1]		20	700	USEPA OW (USEPA 2015)
Chlorpyrifos	2921-88-2	0.001		Not classifiable as to human carcinogenicity (Class D)[1]		20	7	ATSDR (1997)
Chrysene	218-01-9		0.001	Probable human carcinogen (Group B2)[1]	Y		10	IRIS*
Cobalt	7440-48-4	0.0003		Has not been classified by the USEPA		20	2	NCEA PPRTV (USEPA 2008d)
Cyanide	57-12-5	0.00063		Inadequate information to assess carcinogenic potential[4]		20	4.2	IRIS (USEPA 2010b)
4,4'-DDE (Dichlorodiphenyldichloroethylene)	72-55-9		0.167	Likely to be carcinogenic to humans[4]			0.20	USEPA OW (USEPA 2008a)
Dibenz(a,h)anthracene	53-70-3		1	Probable human carcinogen (Group B2)[1]	Y		0.01	IRIS*
Dibromochloromethane (Chlorodibromomethane)	124-48-1		0.043	Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential[3]			0.78	USEPA OW (USEPA 2005a)
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8		0.81	Likely to be carcinogenic to humans[4]	Y		0.016	NCEA PPRTV (USEPA 2006)

Constituent	CASRN	Oral RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)$^{-1}$	Carcinogenicity Classification	ADAF	RSC (%)	Proposed Criterion (µg/L)	Primary Basis for Proposed Revision
1,2-Dichlorobenzene (ortho)	95-50-1	0.031		Not classifiable as to human carcinogenicity (Class D)[1]		20	210	ATSDR (2006)
1,3-Dichlorobenzene (meta)	541-73-1	0.00070		Not classifiable as to human carcinogenicity (Class D)[1]		20	4.7	ATSDR (2006)
1,4-Dichlorobenzene (para)	106-46-7	0.0023 Note: NJDEP applied additional UF of 10 to account for potential cancer risk		Suggestive evidence of carcinogenicity[4]		20	15	NJDWQI (2009)
1,1-Dichloroethane (1,1-DCA)	75-34-3	0.00325 Note: NJDEP applied additional UF of 10 to account for potential cancer risk		Suggestive evidence of carcinogenicity[4]		20	22	NJDWQI (2009)
1,1-Dichloroethylene (1,1-DCE)	75-35-4	0.0046 Note: NJDEP		Suggestive evidence of carcinogenicity[4]		20	31	IRIS (USEPA 2002b)

Constituent	CASRN	Oral RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)$^{-1}$	Carcinogenicity Classification	ADAF	RSC (%)	Proposed Criterion (µg/L)	Primary Basis for Proposed Revision
		applied additional UF of 10 to account for potential cancer risk						
cis-1,2-Dichloroethylene	156-59-2	0.0017		Inadequate information to assess carcinogenic potential[4]		20	11	IRIS (USEPA 2010a)
1,2-Dichloropropane	78-87-5		0.036	Probable human carcinogen (Group B2)[1]			0.92	CalEPA (1999a)
Dimethyl phthalate	131-11-3	3		Not classifiable as to human carcinogenicity[1]		20	20000	USEPA OW (USEPA 1980)
Di-n-octyl phthalate	117-84-0	0.012		Inadequate information to assess carcinogenic potential[4]		20	80.	NCEA PPRTV (USEPA 2012)
Ethion	563-12-2	0.0004		Has not been classified by the USEPA		20	3	ATSDR (2000)
Ethylbenzene	100-41-4	0.022		Not classifiable as to human carcinogenicity[1]		20	150	USEPA OW (USEPA 2015)
Ethylene glycol	107-21-1	0.76		Has not been classified by the USEPA		20	5100	ATSDR (2010)
Heptachlor	76-44-8		4.1	Probable human carcinogen (Group B2)[1]			0.0081	CalEPA (1999b)
Heptachlor epoxide	1024-57-3		5.5	Probable human carcinogen (Group B2)[1]			0.0061	CalEPA (1999b)

Constituent	CASRN	Oral RfD (mg/kg/day)	Oral Slope Factor $(mg/kg/day)^{-1}$	Carcinogenicity Classification	ADAF	RSC (%)	Proposed Criterion (µg/L)	Primary Basis for Proposed Revision
Hexachlorobenzene	118-74-1		1.02	Probable human carcinogen (Group B2)[1]			0.033	USEPA OW (USEPA 2015)
Hexachlorobutadiene	87-68-3		0.04	Likely to be carcinogenic to humans by the oral route of exposure[3]			0.8	USEPA OW (USEPA 2003a)
Hexachloroethane	67-72-1		0.04	Likely to be carcinogenic to humans[4]			0.8	IRIS (USEPA 2011b)
Indeno(1,2,3-c,d)pyrene	193-39-5		0.1	Probable human carcinogen (Group B2)[1]	Y		0.1	IRIS*
Methanol	67-56-1	1.9		Has not been classified by the USEPA		20	13000	IRIS (USEPA 2013b)
Methoxychlor	72-43-5	0.00002		Not classifiable as to human carcinogenicity[1]		20	0.1	CalEPA (2010)
Methylene chloride	75-09-2		0.002	Likely to be carcinogenic to humans[4]	Y		6	IRIS (USEPA 2011a)
Methyl ethyl ketone (MEK) (2-Butanone)	78-93-3	0.639		Data are inadequate for an assessment of human carcinogenic potential[3]		20	4300	IRIS (USEPA 2003b) and NJDWQI (2009)
Nitrobenzene	98-95-3	0.00018 Note: NJDEP applied additional UF of 10 to account for	Not derived by the USEPA (2009)	Likely to be carcinogenic to humans[4]		20	1.2	IRIS (USEPA 2009a)

Constituent	CASRN	Oral RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)$^{-1}$	Carcinogenicity Classification	ADAF	RSC (%)	Proposed Criterion (µg/L)	Primary Basis for Proposed Revision
		potential cancer risk						
Pentachlorophenol	87-86-5		0.4	Likely to be carcinogenic to humans[4]			0.08	IRIS (USEPA 2009b)
1,1,2,2-Tetrachloroethane	79-34-5		0.2	Suggestive evidence of carcinogenicity[4]			0.2	IRIS (USEPA 2010c) and NJDWQI (2009)
Tetrahydrofuran	109-99-9	0.093 Note: NJDEP applied additional UF of 10 to account for potential cancer risk	Not derived by the USEPA (2010)	Suggestive evidence of carcinogenicity[4]		20	620	IRIS (USEPA 2010d)
1,2,4-Trichlorobenzene	120-82-1		0.029	Likely to be carcinogenic to humans[4]			1.1	NCEA PPRTV (USEPA 2009d)
1,1,1-Trichloroethane (1,1,1-TCA)	71-55-6	0.28		Inadequate information to assess carcinogenic potential[4]		20	1900	NJDWQI (2009)

Constituent	CASRN	Oral RfD (mg/kg/day)	Oral Slope Factor $(mg/kg/day)^{-1}$	Carcinogenicity Classification	ADAF	RSC (%)	Proposed Criterion (µg/L)	Primary Basis for Proposed Revision
1,1,2-Trichloroethane	79-00-5		0.057	Suggestive evidence of carcinogenic potential[4]			0.58	IRIS (USEPA 1986b) and NJDWQI (2009)
Trichloroethylene (TCE)	79-01-6		0.046	Carcinogenic to humans[4]	Y		0.28	IRIS (USEPA 2011c)
2,4,6-Trichlorophenol	88-06-2		0.011	Likely to be carcinogenic to humans[4]			3.0	IRIS (USEPA 1990e) and NJDWQI (2009)
Vinyl chloride	75-01-4		1.5	Carcinogenic to humans[4]			0.022	IRIS (USEPA 2000b) and NJDWQI (2009)

Table B Footnotes:

[1] USEPA. 1986. Guidelines for Carcinogen Risk Assessment. (EPA/630/R-00/004). Washington, DC: Risk Assessment Forum.

[2] USEPA. 1996. Proposed Guidelines for Carcinogen Risk Assessment. EPA-600-P-92-003C. Washington, DC: Risk Assessment Forum.

[3] USEPA. 1999. Guidelines for Carcinogen Risk Assessment. Preliminary Draft. Risk Assessment Forum, Washington, DC. July 1999.

[4] USEPA. 2005b. Guidelines for carcinogen risk assessment. (EPA/630/P-03/001F). Washington, DC: Risk Assessment Forum.

Table B Notes:

***** The USEPA provides guidance for the risk evaluation of certain polycyclic aromatic hydrocarbons (PAHs) (USEPA 1993). For certain PAHs classified as group B2 carcinogens, "estimated order of potential potency" factors have been calculated relative to benzo(a)pyrene. The cancer slope factor for these group B2 PAHs is derived by the application of these compound-specific factors to the benzo(a)pyrene cancer slope factor.

ADAF = Age Dependent Adjustment Factor. The USEPA recommends the application of ADAFs for carcinogens with a mutagenic mode of action (MOA) when the exposure period includes early life, as is the case with chronic exposure to drinking water contaminants (USEPA 2005c). Since ground water criteria are based on chronic exposure through drinking water, ADAFs are applied using the drinking water consumption assumptions for each age grouping (that is, < 2 years old, 2 to < 16 years old) as described by the NJDWQI (2015).

ATSDR = Agency for Toxic Substances and Disease Registry

CalEPA = California Environmental Protection Agency

Oral slope factor (cancer slope factor) was based on data retrieved from the USEPA IRIS database, except where noted, to develop a criterion that corresponds with the upper bound lifetime excess cancer risk of 10^{-6}. Details on using an alternative slope factor and/or uncertainty factor are available per constituent below.

CASRN = Chemical Abstracts Service Registry Number is a unique numerical identifier assigned to every chemical substance described in the open scientific literature.

IRIS = USEPA Integrated Risk Information System

NCEA PPRTV = USEPA National Center for Environmental Assessment's Provisional Peer-Reviewed Toxicity Values

NJDWQI = New Jersey Drinking Water Quality Institute

RfD = reference dose. RfDs were based on data retrieved from the USEPA IRIS database except where noted. Details on using an alternative RfD are available per constituent below.

RSC = relative source contribution. A relative source contribution factor other than the default value of 20% for drinking water was used when information was available to develop a chemical-specific RSC higher than 20%. Details on using an alternative RSC are available per constituent below.

UF = uncertainty factor

USEPA OW = United States Environmental Protection Agency's Office of Water

For information about the basis for previous ground water criteria recommendations, see the 2017 Basis and Background for Criteria Derivation and Practical Quantitation Levels (https://www.nj.gov/dep/wms/bears/docs/gwqsbb2017final.pdf) and the 2004 Basis and Background document (https://www.nj.gov/dep/wms/bears/docs/gwqsbb2004.pdf).

4.1.1 Description of Criteria Updates

The bases for the criteria revisions are shown above in Table B. The Department has provided additional information below for clarification or to explain the variations from the standard methodology, default assumptions, and approaches used to develop individual specific ground water quality criteria.

a. Acrylamide: The existing ground water quality criterion for acrylamide is based on a cancer slope factor of 4.5 $(mg/kg/day)^{-1}$ from a 1988 IRIS assessment. The updated criterion is based on an updated IRIS assessment (USEPA 2010e). Based on the combined incidence of tumors in multiple sites of female rats, an updated cancer slope factor of 0.52 $(mg/kg/day)^{-1}$ was derived. As the USEPA (2010e) concluded that the carcinogenicity of acrylamide occurs through a mutagenic mode of action, the age-dependent adjustment factors are applied to the slope factor. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.008 µg/L to 0.024 µg/L.

b. Benz(a)anthracene: The updated ground water quality criterion for benz(a)anthracene is based on the updated IRIS assessment for benzo(a)pyrene (USEPA 2017). Based on USEPA guidance (USEPA 1993), the cancer slope factor for benz(a)anthracene was derived from the benzo(a)pyrene cancer slope factor of 1 $(mg/kg/day)^{-1}$ with application of an "estimated order of potential potency" factor of 0.1 resulting in a cancer slope factor of 0.1 $(mg/kg/day)^{-1}$. Because carcinogenic PAHs such as benz(a)anthracene have a mutagenic mode of action for carcinogenicity, the age-dependent adjustment factors are applied to the slope factor. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.05 µg/L to 0.1 µg/L.

c. Benzene: Utilizing the USEPA's 1996 Proposed Guidelines for Carcinogen Risk Assessment (USEPA 1996), benzene was classified as Group A, "known/likely human carcinogen" (USEPA 2000a). The existing ground water quality criterion for benzene is based on a cancer slope factor from a health-based MCL developed by the New Jersey Drinking Water Quality Institute (NJDWQI 1987a). This cancer slope factor of 0.23 $(mg/kg/day)^{-1}$ is based on the 95th percentile upper confidence limit of linear mathematical modeling of leukemia mortality data and benzene exposure in three pooled worker cohort studies as discussed in NJDWQI (1987a).

A 2000 IRIS assessment for benzene derived a cancer slope factor range of 0.015 to 0.055 $(mg/kg/day)^{-1}$ (USEPA 2000a) based on two different exposure assessments (that is, one based on worst-case [higher] exposure assumptions and the other based on more likely [lower] exposure assumptions) for an updated follow-up evaluation of leukemia mortality in the same cohort of individuals with occupational exposure to benzene used by the NJDWQI (1987a). These USEPA (2000a) IRIS slope factors are based on assessment of cancer risk from the updated follow-up data presented in USEPA (1998)

and inhalation-to-oral extrapolation for cancer risk from benzene presented in USEPA (1999a). The 2000 IRIS cancer slope factors are based on the maximum likelihood estimate (that is, the central tendency estimate) of the slope of the modeled data. However, use of the central tendency estimate is contrary to the USEPA cancer risk assessment guidance (USEPA 2005b), which recommends the use of the 95th percentile upper confidence limit when developing a cancer slope factor based on epidemiological data that is outside of the exposure range.

The NJDWQI (2009) updated its assessment of benzene based on a more stringent cancer slope factor of 0.28 (mg/kg/day)$^{-1}$. The NJDWQI slope factor is based on the same updated follow-up of the exposed workers, more likely (lower) exposure assumptions, and inhalation-to-oral extrapolation used by IRIS to derive its higher slope factor of 0.055 (mg/kg/day)$^{-1}$ (USEPA 2000a). However, the NJDWQI (2009) used the 95th percentile upper confidence limit of the slope factor, as recommended by the USEPA (2005b) cancer risk assessment guidance, instead of the less stringent maximum likelihood (central tendency) estimate used by IRIS (USEPA 2000a). Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.2 µg/L to 0.12 µg/L.

d. Benzo(a)pyrene (BaP): The existing ground water quality criterion for BaP is based on a cancer slope factor of 7.3 (mg/kg/day)$^{-1}$ from a 1992 IRIS assessment. An updated IRIS assessment of BaP derived an updated cancer slope factor of 1 (mg/kg/day)$^{-1}$ based on tumors in multiple sites of the alimentary tracts of rats (USEPA 2017). As the USEPA concluded that the carcinogenicity of BaP occurs through a mutagenic mode of action, the age-dependent adjustment factors are applied to the slope factor. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.005 µg/L to 0.01 µg/L.

e. Benzo(b)fluoranthene (3,4-Benzofluoranthene): The updated ground water quality criterion for benzo(b)fluoranthene is based on the updated IRIS assessment for benzo(a)pyrene (USEPA 2017). Based on USEPA guidance (USEPA 1993), the cancer slope factor for benzo(b)fluoranthene was derived from the benzo(a)pyrene cancer slope factor of 1 (mg/kg/day)$^{-1}$ with application of an "estimated order of potential potency" factor of 0.1 resulting in a cancer slope factor of 0.1 (mg/kg/day)$^{-1}$. Because carcinogenic PAHs such as benzo(b)fluoranthene have a mutagenic mode of action for carcinogenicity, the age-dependent adjustment factors are applied to the slope factor. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.05 µg/L to 0.1 µg/L.

f. Benzo(k)fluoranthene: The updated ground water quality criterion for benzo(k)fluoranthene is based on the updated IRIS assessment for benzo(a)pyrene (USEPA 2017). Based on USEPA guidance (USEPA 1993), the cancer slope factor for benzo(k)fluoranthene was derived from the benzo(a)pyrene cancer slope factor of 1

(mg/kg/day)$^{-1}$ with application of an "estimated order of potential potency" factor of 0.01 resulting in a cancer slope factor of 0.01 (mg/kg/day)$^{-1}$. Because carcinogenic PAHs such as benzo(k)fluoranthene have a mutagenic mode of action for carcinogenicity, the age-dependent adjustment factors are applied to the slope factor. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.5 µg/L to 1 µg/L.

g. 1,1-Biphenyl (Diphenyl): The existing ground water quality criterion for 1,1-biphenyl is based on an RfD of 0.05 mg/kg/day from a 1987 IRIS assessment. In 2013, the USEPA developed an updated IRIS assessment for 1,1-biphenyl (USEPA 2013a) that concludes that biphenyl has suggestive evidence of carcinogenic potential. Based on the observation of increased incidence of liver tumors in female mice exposed to biphenyl in the diet for 104 weeks, the USEPA derived a cancer slope factor of 0.0082 (mg/kg/day)$^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 400 µg/L to 4.1 µg/L.

h. Bromodichloromethane: Utilizing the USEPA's 1999 Review Draft Guidelines for Carcinogen Risk Assessment (USEPA 1999b), the USEPA classified bromodichloromethane as "likely to be carcinogenic to humans" by the oral route in 2005 (USEPA 2005a). The existing ground water quality criterion for bromodichloromethane is based on a cancer slope factor of 0.062 (mg/kg/day)$^{-1}$, which is based on kidney tumors in male mice, derived in a 1992 IRIS assessment (USEPA 1992a).

Using the same tumor data as the 1992 IRIS assessment and more current carcinogen risk assessment approaches, the USEPA (2005a) developed a cancer slope factor of 0.034 (mg/kg/day)$^{-1}$. Based on this updated cancer slope factor, which is based on more current risk assessment approaches, the Department is proposing to revise the criterion from 0.6 µg/L to 0.98 µg/L.

i. Bromoform: Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified bromoform as Group B2, "probable human carcinogen" in 1990 (USEPA 1990a). The existing ground water quality criterion for bromoform is based on increased incidence of tumors of the large intestine in female rats, which was used by the USEPA's IRIS program to derive a cancer slope factor of 0.0079 (mg/kg/day)$^{-1}$ (USEPA 1990a).

Using the same tumor data as IRIS, but more current carcinogen risk assessment approaches, the USEPA (2005a) developed a cancer slope factor of 0.0045 (mg/kg/day)$^{-1}$. Based on this updated cancer slope factor, which is based on more current risk assessment approaches, the Department is proposing to revise the criterion from 4 µg/L to 7.4 µg/L.

j. Butyl benzyl phthalate: Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified butyl benzyl phthalate as Group C, "possible human carcinogen" in 1989 (USEPA 1989a). The existing ground water quality criterion for butyl benzyl phthalate is based on an RfD of 0.02 mg/kg/day from a 1989 IRIS assessment which includes incorporation of an additional UF of 10, based on the Department's policy for contaminants with evidence of human carcinogenic potential in the absence of an appropriate cancer slope factor.

In 2002, the USEPA developed a Provisional Peer-Reviewed Toxicity Value (PPRTV) for butyl benzyl phthalate that classifies it as likely to be carcinogenic to humans and includes a cancer slope factor (USEPA 2002c). Based on the observation of pancreatic tumors in male rats following chronic dietary exposure to butyl benzyl phthalate, the USEPA derived a cancer slope factor of 0.0019 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 100 µg/L to 18 µg/L.

k. Cadmium: The USEPA's IRIS (1989b) program classified cadmium as a "probable human carcinogen" via *inhalation* but noted that *oral* exposure studies in laboratory rodents provide no evidence of carcinogenicity. The existing ground water quality criterion for cadmium is based on an RfD from the 1989 IRIS assessment of 0.0005 mg/kg/day. The RfD was based on kidney damage in humans from a review of animal and human studies (as reported in USEPA 1986c).

ATSDR (2012) derived a chronic-duration oral minimal risk level (MRL) for cadmium. By conducting a meta-analysis of environmental epidemiology studies examining indicators of renal function published after the 1989 IRIS assessment, ATSDR derived an MRL of 0.00011 mg/kg/day. As MRLs and RfDs are derived through a generally similar process (that is, the application of appropriate UFs to a POD), chronic MRLs are considered equivalent to RfDs for the purpose of ground water quality criteria development. Based on this updated toxicity factor, the Department is proposing to revise the criterion from 4 µg/L to 0.92 µg/L.

l. 4-Chloroaniline (p-Chloroaniline): The existing ground water quality criterion for 4-chloroaniline is based on an RfD of 0.004 mg/kg/day from a 1988 IRIS assessment where carcinogenicity was not assessed (USEPA 1988a). The updated criterion is based on a more recent PPRTV (USEPA 2008c). Based on adrenal tumors in rats, the USEPA (2008c) derived a cancer slope factor of 0.19 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 30 µg/L to 0.18 µg/L.

m. 4-Chloro-3-methylphenol (3-methyl-4-chlorophenol): An interim generic ground water quality criterion of 100 µg/L currently exists. The USEPA's IRIS program has not assessed 4-chloro-3-methylphenol. Under the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), 3-methyl-4-chlorophenol is classified as Group D, "not

classifiable as to human carcinogenicity" (USEPA 2015). In 2015, the USEPA Office of Water updated its human health ambient water quality criteria for 3-methyl-4-chlorophenol (USEPA 2015) based on a 1997 USEPA Office of Pesticide Programs Reregistration Eligibility Decision (USEPA 1997b). Based on decreased brain weight in female rats from a 1993 chronic dietary study, the USEPA derived an RfD of 0.1 mg/kg/day. The 1993 chronic rat study was also considered in a 2009 PPRTV assessment (USEPA 2009c). However, the USEPA did not derive an RfD based on this study because it was unpublished. The USEPA derived a *chronic screening value* of 0.10 mg/kg/day based on skewed offspring sex ratios in an unpublished 1992 developmental rat study (USEPA 2009c).

Although based on different endpoints from different study designs, the RfD of 0.1 mg/kg/day used by the USEPA Office of Water in 2015 is identical to the screening value derived in the 2009 PPRTV assessment. Based on the updated RfD, the Department is proposing a specific criterion of 700 µg/L.

n. Chlorpyrifos: The existing ground water quality criterion for chlorpyrifos is based on the RfD of 0.003 mg/kg/day from a 1987 IRIS assessment that was removed from the IRIS database in 2011.

The updated criterion is based on a risk assessment by ATSDR (1997). Based on acetylcholinesterase inhibition, ATSDR derived a chronic MRL of 0.001 mg/kg/day. As MRLs and RfDs are derived through a generally similar process (that is, the application of appropriate UFs to a POD), chronic MRLs are considered equivalent to RfDs for the purpose of ground water quality criteria calculations. Based on this toxicity factor, the Department is proposing to revise the criterion from 20 µg/L to 7 µg/L.

o. Chrysene: The updated ground water quality criterion for chrysene is based on the updated IRIS assessment for benzo(a)pyrene (USEPA 2017). Based on USEPA guidance (USEPA 1993), the cancer slope factor for chrysene was derived from the benzo(a)pyrene cancer slope factor of 1 $(mg/kg/day)^{-1}$ with application of an "estimated order of potential potency" factor of 0.001 resulting in a cancer slope factor of 0.001 $(mg/kg/day)^{-1}$. Because carcinogenic PAHs such as chrysene have a mutagenic mode of action for carcinogenicity, the age-dependent adjustment factors are applied to the slope factor. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 5 µg/L to 10 µg/L.

p. Cobalt: The existing ground water quality criterion for cobalt is based on an RfD of 0.02 mg/kg/day from a 2002 USEPA assessment (NJDEP 2017). The USEPA's IRIS program has not assessed cobalt.

The updated criterion for cobalt is based on a more recent PPRTV (USEPA 2008d). Cobalt is known to decrease iodine uptake by the thyroid in humans, potentially resulting in decreased production of thyroid hormones. Based on

decreased iodine uptake in humans, the USEPA derived an RfD of 0.0003 mg/kg/day. Based on this updated RfD, the Department is proposing to revise the criterion from 100 µg/L to 2 µg/L.

q. Cyanide: The current ground water quality criterion for cyanide is based on an RfD of 0.02 mg/kg/day, which is based on myelin degeneration in the central nervous system and increased thyroid gland weight in a 1979 rat study, derived in an IRIS assessment (originally posted on the IRIS database in 1985, as cited in USEPA 2010b). Under the USEPA's 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005b), there is "inadequate information to assess the carcinogenic potential" of cyanide (USEPA 2010b). A 2010 IRIS assessment derived an RfD of 0.00063 mg/kg/day using benchmark dose modeling, based on decreased cauda epididymis weight effect in male rats exposed to cyanide in drinking water in a 1993 study by the National Toxicology Program (USEPA 2010b). Based on this updated RfD, the Department is proposing to revise the criterion from 100 µg/L to 4.2 µg/L.

r. 4,4'-DDE (Dichlorodiphenyldichloroethylene): Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified 4,4'-DDE as Group B2, "probable human carcinogen" in 1988 (USEPA 1988b). The existing ground water quality criterion for 4,4'-DDE is based on increased incidence of liver tumors in mice and hamsters, which was used by the USEPA's IRIS program to derive a cancer slope factor of 0.34 $(mg/kg/day)^{-1}$ (USEPA 1988b).

Using the most sensitive of these data (female B6C3F1 mice) and more current carcinogen risk assessment approaches, the USEPA's Office of Water (2008a) developed a cancer slope factor of 0.167 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.1 µg/L to 0.20 µg/L.

s. Dibenz(a,h)anthracene: The updated ground water quality criterion for dibenz(a,h)anthracene is based on the updated IRIS assessment for benzo(a)pyrene (USEPA 2017). Based on USEPA guidance (USEPA 1993), the cancer slope factor for dibenz(a,h)anthracene was derived from the benzo(a)pyrene cancer slope factor of 1 $(mg/kg/day)^{-1}$ with application of an "estimated order of potential potency" factor of 1 resulting in a cancer slope factor of 1 $(mg/kg/day)^{-1}$. Because carcinogenic PAHs such as dibenz(a,h)anthracene have a mutagenic mode of action for carcinogenicity, the age-dependent adjustment factors are applied to the cancer slope factor. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.005 µg/L to 0.01 µg/L.

t. Dibromochloromethane (Chlorodibromomethane): Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified dibromochloromethane as Group C, "possible human carcinogen" in 1990

(USEPA 1990b). The basis for the existing ground water quality criterion is increased incidence of liver tumors in female mice, which was used by the USEPA's IRIS program to derive a cancer slope factor of 0.084 $(mg/kg/day)^{-1}$ (USEPA 1990b).

Using the same tumor data as IRIS and more current carcinogen risk assessment approaches, the USEPA (2005a) developed a cancer slope factor of 0.043 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.4 µg/L to 0.78 µg/L.

u. 1,2-Dibromo-3-chloropropane (DBCP): Utilizing the USEPA's Guidelines for Carcinogen Risk Assessment (USEPA 2005b), the USEPA classified DBCP as "likely to be carcinogenic to humans" in 2006 (USEPA 2006). The USEPA's IRIS program has not derived an RfD or cancer slope factor for DBCP. The basis for the existing ground water quality criterion is a cancer slope factor of 1.4 $(mg/kg/day)^{-1}$, which is based on stomach, kidney, and liver tumors in rats from a 1977 dietary study from the USEPA's Health Effects Assessment Summary Tables (USEPA 1997a).

Using data from the same 1977 study and applying benchmark dose modeling, a USEPA (2006) PPRTV assessment derived a cancer slope factor of 0.81 $(mg/kg/day)^{-1}$ based on kidney tumors in male rats. Based on a weight of evidence evaluation, the USEPA concluded that DBCP is carcinogenic by a mutagenic mode of action (USEPA 2006). As recommended for contaminants with a mutagenic mode of action for carcinogenicity in the USEPA (2005b) risk assessment guidance, age-dependent adjustment factors were applied to the cancer slope factor in the 2006 PPRTV assessment (USEPA 2006). Based on this updated cancer slope factor of 0.81 $(mg/kg/day)^{-1}$, and the application of age-dependent adjustment factors, the Department is proposing to revise the criterion from 0.02 µg/L to 0.016 µg/L.

v. 1,2-Dichlorobenzene (ortho): Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified 1,2-dichlorobenzene (ortho) as Group D, "not classifiable as to human carcinogenicity" in 1989 (USEPA 1989c). The existing ground water quality criterion for 1,2-dichlorobenzene (ortho) is based on an RfD from a health-based MCL developed by the NJDWQI (1987b). This RfD of 0.086 mg/kg/day is based on kidney lesions in male rats in a 1985 chronic gavage study. Similarly, an RfD of 0.09 mg/kg/day based on the same 1985 principal study was derived by a 1989 IRIS assessment (USEPA 1989c).

In 2006, ATSDR derived a chronic MRL of 0.3 mg/kg/day based on the development of kidney lesions in rats from the same 1985 principal study as the 1987 NJDWQI and 1989 IRIS RfDs but using benchmark dose modeling. In deriving its MRL, ATSDR did not apply a UF for database deficiencies, consistent with its general approach for application of UFs in MRL derivation. However, this UF is included in the NJDWQI (1987b) and the USEPA (1989c) RfDs. Recognizing a lack of reproductive and developmental data for 1,2-dichlorobenzene (that is, database deficiencies), the

Department applied a UF of 10 to account for this deficiency, along with UFs for inter- and intra-species extrapolation (a factor of 10 for each). Applying a total UF of 1000 to the ATSDR POD (30.74 mg/kg/day) yields a chronic MRL of 0.031 mg/kg/day. As MRLs and RfDs are derived through a similar process (that is, the application of appropriate UFs to a POD), chronic MRLs are generally considered equivalent to RfDs for the purpose of ground water quality criteria calculations. Based on this updated toxicity factor, the Department is proposing to revise the criterion from 600 µg/L to 210 µg/L.

The UFs applied in the derivation of the RfD are:

10 (interspecies), to account for animal-to-human extrapolation.
10 (intraspecies variability), to protect sensitive human subpopulations.
1 (duration of exposure), no adjustment needed as the principal study involved chronic exposure.
1 (use of a LOAEL, NOAEL or BMDL as the POD), no adjustment needed as a BMDL was used.
10 (database deficiencies), to account for a lack of reproductive and developmental data.
UF Total = 1000
RfD = POD/UF Total = (30.74 mg/kg/day) / 1000 = 0.03074 (rounds to 0.031 mg/kg/day)

w. 1,3-Dichlorobenzene (meta): Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified 1,3-dichlorobenzene (meta) as Group D, "not classifiable as to human carcinogenicity" in 1990 (USEPA 1990c). The USEPA's IRIS program has not assessed 1,3-dichlorobenzene. The existing ground water quality criterion for 1,3-dichlorobenzene (meta) is based on an RfD of 0.086 mg/kg/day from a health-based MCL developed by the NJDWQI (1987b). This RfD is based on the use of a chronic gavage study in mice of the surrogate chemical 1,2-dichlorobenzene where kidney damage was observed.

ATSDR (2006) derived an intermediate duration MRL of 0.02 mg/kg/day from a POD of 2.1 mg/kg/day using benchmark dose modeling, based on the histological changes in the pituitary gland in male rats from a 1995 subchronic gavage study of 1,3-dichlorobenzene.

In 2009, the NJDWQI reevaluated 1,3-dichlorobenzene and developed an RfD of 0.0009 mg/kg/day based on the LOAEL for cholesterol and lactate dehydrogenase changes (male) as well as histological changes in the thyroid gland (male and female) and the pituitary gland (male) of rats from the same 1995 subchronic gavage study used by ATSDR (NJDWQI 2009).

Based on the USEPA (2012) guidance, it is preferable to derive an RfD based on benchmark dose modeling rather than on a LOAEL, as benchmark dose modeling considers all the dose-response data for the critical effect from the principal

study. Therefore, the 2006 ATSDR intermediate MRL was selected as the starting point for development of the recommended RfD. Because the ATSDR MRL did not account for the lack of reproductive data with a UF for database deficiencies, consistent with its approach for application of UFs in general, and it was intended to protect for less-than-chronic (intermediate) duration of exposure, the Department deems it appropriate to apply additional UFs of 3 for database deficiencies and 10 for less-than-chronic duration of the principal study. Combined with the UFs used by ATSDR (UF_{human} = 10, UF_{animal} = 10), a total UF of 3000 is applied to the POD, resulting in an RfD of 0.00070 mg/kg/ day, which is slightly more stringent than the 2009 NJDWQI RfD of 0.0009 mg/kg/day. Based on this updated RfD, the Department is proposing to revise the criterion from 600 µg/L to 4.7 µg/L.

The UFs applied in the derivation of the RfD are:

10 (interspecies), to account for animal-to-human extrapolation.
10 (intraspecies variability), to protect sensitive human subpopulations.
10 (duration of exposure), the principal study involved subchronic exposure.
1 (use of a LOAEL, NOAEL or BMDL as the POD), no adjustment needed as a BMDL was used.
3 (database deficiencies), to account for a lack of reproductive data for 1,3-dichlorobenzene.
UF Total = 3000
RfD = POD/UF Total = (2.1 mg/kg/day) / 3000 = 0.00070 mg/kg/day

x. 1,4-Dichlorobenzene: The NJDWQI classified 1,4-dichlorobenzene (para) as Group C, "possible human carcinogen" (NJDWQI 1994). The USEPA's IRIS program has not derived an RfD or cancer slope factor for 1,4-dichlorobenzene. The existing ground water quality criterion for 1,4-dichlorobenzene (para) is based on an MCL promulgated by the USEPA. This MCL is based on an RfD of 0.0107 mg/kg/day, which is based on a NOAEL from a 1987 subchronic mouse study (reviewed in NJDWQI 2009). Consistent with the NJDWQI policy for contaminants with evidence of human carcinogenic potential, an additional UF of 10 was used in deriving the RfD.

In 2009, the NJDWQI reevaluated 1,4-dichlorobenzene (para) and developed an RfD of 0.0023 mg/kg/day based on liver, kidney, and blood effects in dogs from a 1996 chronic capsule study (NJDWQI 2009). As with the 1994 NJDWQI RfD, a UF of 10 for potential carcinogenicity was used in deriving the RfD. Based on the updated RfD of 0.0023 mg/kg/day, the Department is proposing to revise the criterion from 75 µg/L to 15 µg/L.

y. 1,1-Dichloroethane: The NJDWQI classified 1,1-dichloroethane as New Jersey Category II (equivalent to the USEPA "suggestive evidence of human carcinogenic

potential") (NJDWQI 2009). The USEPA's IRIS program has not published an RfD or cancer slope factor for 1,1-dichloroethane. The existing ground water quality criterion for 1,1-dichloroethane is based on an RfD of 0.0065 mg/kg/day from a health-based MCL developed by the NJDWQI (1994). This RfD is based on kidney damage in cats from a 1971 subchronic inhalation study with a NOAEL of 500 ppm (2025 mg/m^3) that is equivalent to an oral dose of 32.5 mg/kg/day.

In 2009, the NJDWQI reevaluated 1,1-dichloroethane and developed an RfD of 0.00325 mg/kg/day based on the same endpoint in the same 1971 cat study used in NJDWQI (1994). In deriving the updated RfD, the NJDWQI removed a UF of 5 (for small sample size) used in the 1994 RfD and incorporated a UF of 10 (for suggestive carcinogenicity). Based on the updated RfD of 0.00325 mg/kg/day, the Department is proposing to revise the criterion from 50 µg/L to 22 µg/L.

The UFs applied in the derivation of the RfD are:

10 (interspecies), to account for animal-to-human extrapolation.
10 (intraspecies variability), to protect sensitive human subpopulations.
10 (duration of exposure), the principal study involved subchronic exposure.
1 (use of a LOAEL, NOAEL or BMDL as the POD), no adjustment needed as a NOAEL used.
1 (database deficiencies), no adjustment judged necessary.
10 (NJDEP Group C/suggestive carcinogen policy), 1,1-dichloroethane identified as a suggestive human carcinogen, and there is no available cancer slope factor.
UF Total = 10,000
RfD = POD/UF Total = (32.5 mg/kg/day) / 10,000 = 0.00325 mg/kg/day

z. 1,1-Dichloroethylene (1,1-DCE): The current ground water quality criterion for 1,1-dichloroethylene is based on an RfD from a Health-based MCL developed by the NJDWQI (1987c). This RfD of 0.00014 mg/kg/day is based on liver necrosis in mice chronically exposed via gavage in a 1982 study. The NJDWQI classified 1,1-dichloroethylene as a Group C carcinogen. Consistent with the NJDWQI policy for contaminants with evidence of human carcinogenic potential, an additional UF of 10 was used in deriving the RfD.

In 2009, the NJDWQI reevaluated 1,1-dichloroethylene and developed an RfD of 0.009 mg/kg/day based on the NOAEL for fatty changes in the liver of rats from a 1983 chronic drinking water study (NJDWQI 2009). Drinking water studies are preferred to gavage studies for risk assessment of contaminants such as 1,1-dichloroethylene. As with the 1987 NJDWQI RfD, a UF of 10 to account for potential carcinogenicity was used in deriving the RfD.

In 2002, the USEPA's IRIS program derived an RfD of 0.046 mg/kg/day, based on the same principal study and endpoint as the 2009 NJDWQI RfD but using benchmark dose modeling (USEPA 2002b). Under the USEPA's 1986 Guidelines for Carcinogen Risk

Assessment (USEPA 1986a) and 1999 Review Draft Guidelines for Carcinogen Risk Assessment (USEPA 1999b), 1,1-dichloroethylene is classified as Group C, "possible human carcinogen" and exhibits "suggestive evidence" of carcinogenicity but not sufficient evidence to assess human carcinogenic potential, respectively (USEPA 2002b). Specifically, the USEPA (2002b) concluded that 1,1-dichloroethylene exhibits suggestive evidence of carcinogenicity following inhalation exposure in studies in rodents, but that the data for 1,1-dichloroethylene are inadequate for an assessment of human carcinogenic potential by the oral route. Because it is preferable to base an RfD on benchmark dose modeling rather than on a NOAEL under current risk assessment approaches, the RfD of 0.046 mg/kg/day developed by the USEPA (2002b) is recommended as the starting point for the RfD. However, the Department concludes that there is suggestive evidence for carcinogenicity of 1,1-dichloroethylene by the oral route for reasons presented in NJDWQI (2009). Therefore, an additional UF of 10 is applied to account for potential carcinogenicity when deriving the criterion based on the IRIS RfD of 0.046 mg/kg/day. Based on this updated RfD, the Department is proposing to revise the criterion from 1 µg/L to 31 µg/L.

aa. cis-1,2-Dichloroethylene: The current ground water quality criterion for cis-1,2-dichloroethylene is based on an RfD from a health-based MCL developed by the NJDWQI (1994, 2009). This RfD of 0.01 mg/kg/day is based on decreased hematocrit and hemoglobin from a 1990 subchronic oral study in rats. The NJDWQI classified cis-1,2-dichloroethylene as a noncarcinogen (Group D).

In 2010, IRIS derived an RfD of 0.0017 mg/kg/day (USEPA 2010a) based on increased relative kidney weight in male rats from the same 1990 study as the NJDWQI RfD and with the use of benchmark dose modeling. Under the USEPA's 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005b), the USEPA (2010a) concluded that there is "inadequate information to assess the carcinogenic potential" of cis-1,2-dichloroethylene. Based on this updated RfD of 0.0017 mg/kg/day, the Department is proposing to revise the criterion from 70 µg/L to 11 µg/L.

bb. 1,2-Dichloropropane: The USEPA's HEAST classified 1,2-dichloropropane as Group B2, "probable human carcinogen" (USEPA 1997a). The USEPA's IRIS program has not derived an RfD or cancer slope factor for 1,2-dichloropropane. The existing ground water quality criterion is based on increased incidence of liver tumors in male mice, which was used by the USEPA to derive a HEAST cancer slope factor of 0.068 $(mg/kg/day)^{-1}$ (USEPA 1997a).

Using the same tumor data and more current carcinogen risk assessment approaches, California EPA (CalEPA 1999a) developed a cancer slope factor of 0.036 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.5 µg/L to 0.92 µg/L.

cc. Dimethyl phthalate: An interim generic ground water quality criterion of 100 µg/L currently exists. Under the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), dimethyl phthalate is classified as Group D, "not classifiable as to human carcinogenicity" (USEPA 2015). The USEPA's IRIS program has not derived an RfD or cancer slope factor for dimethyl phthalate.

In 2015, the USEPA Office of Water updated its human health ambient water quality criteria for dimethyl phthalate (USEPA 2015) based on a 1980 Office of Water assessment of phthalates (USEPA 1980). Based on a growth effect in rats orally exposed for 2 years in a 1948 study (Draize et al. 1948), the 1980 USEPA assessment derived an RfD of 10 mg/kg/day based on a NOAEL of 1000 mg/kg/day. This 1948 study does not provide data on numerous other toxicological endpoints that are routinely reported in more recent chronic animal studies.

As stated above, the 1948 rat study (Draize et al. 1948) did not include a comprehensive evaluation of toxicity endpoints (for example, standard biochemical and hematological endpoints). A 2007 PPRTV assessment (USEPA 2007b) concluded that neither Draize et al. (1948) or a subsequent review of this study by Lehman (1955) provided sufficient detail in methodology and data reporting (for example, direction and severity of effects) to identify a NOAEL/LOAEL. Therefore, the 2007 USEPA assessment did not derive an RfD based on the 1948 study, while also noting a general lack of chronic oral studies of dimethyl phthalate in laboratory animals. Instead, the USEPA (2007b) derived an oral subchronic reference screening value of 0.1 mg/kg/day based on decreased serum testosterone levels from a 1980 study in which five-week-old male rats were exposed for one week at a single dose level, while noting that this study was inappropriate for development of a more definitive toxicity factor. The USEPA also noted the general lack of adverse reproductive and developmental effects in offspring following maternal dimethyl phthalate exposure.

Considering the lack of information on chronic toxicological effects that are not reported by Draize et al. (1948), the Department applied a UF of 3 to the USEPA RfD of 10 mg/kg/day to account for database deficiencies. As a result, an RfD of 3 mg/kg/day was used to derive the proposed criterion of 20,000 µg/L.

The UFs applied in the derivation of the RfD are:

10 (interspecies), to account for animal-to-human extrapolation.
10 (intraspecies variability), to protect sensitive human subpopulations.
1 (duration of exposure), the principal study involved chronic exposure.
1 (use of a LOAEL, NOAEL or BMDL as the POD), no adjustment needed as a NOAEL was used.
3 (database deficiencies), to account for a general lack of toxicological information, particularly following chronic exposure.
UF Total = 300

RfD = POD/UF Total = (1000 mg/kg/day) / 300 = 3.3 mg/kg/day (rounded to 3 mg/kg/day)

dd. Di-n-octyl phthalate: The USEPA's IRIS program has not assessed di-n-octyl phthalate. The existing ground water quality criterion for di-n-octyl phthalate is based on an RfD of 0.02 mg/kg/day from the USEPA's HEAST (1997a).

The USEPA developed a PPRTV for di-n-octyl phthalate (USEPA 2012) that includes an updated RfD of 0.012 mg/kg/day based on observations of cytoplasmic vacuolation in the livers of male rats. Based on this updated RfD, the Department is proposing to revise the criterion from 100 µg/L to 80 µg/L.

ee. Ethion: The existing ground water quality criterion for ethion is based on an RfD of 0.0005 mg/kg/day from the USEPA's IRIS (1989d) program. In 2000, ATSDR derived an MRL of 0.0004 mg/kg/day based on brain acetylcholinesterase inhibition in male dogs (ATSDR 2000). As MRLs and RfDs are derived through a generally similar process (that is, the application of appropriate UFs to a POD), chronic MRLs are considered equivalent to RfDs for the purpose of ground water quality criteria calculations. Based on this updated toxicity factor, the Department is proposing to revise the criterion from 4 µg/L to 3 µg/L.

ff. Ethylbenzene: Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified ethylbenzene as Group D, "not classifiable as to human carcinogenicity" in 2015 (USEPA 2015). The existing ground water quality criterion for ethylbenzene is based on an RfD of 0.1 mg/kg/day, which is based on liver and kidney toxicity in female rats exposed via gavage for 182 days in a 1956 study, derived in a 1985 IRIS assessment (USEPA 1985).

In 2015, the USEPA's Office of Water updated the human health ambient water quality criteria for ethylbenzene (USEPA 2015) based on a 2015 Health Canada assessment (HC 2015). Health Canada derived a tolerable daily intake of 0.022 mg/kg/day based on pituitary gland and liver cell toxicity in mice chronically exposed via inhalation in a 1999 National Toxicology Program study and a physiologically based pharmacokinetic (PBPK) model for route-to-route extrapolation. Based on this updated RfD of 0.022 mg/kg/day, the Department is proposing to revise the criterion from 700 µg/L to 150 µg/L.

gg. Ethylene glycol: The existing ground water quality criterion for ethylene glycol is based on an RfD from a 1987 assessment by the NJDWQI (1987d). A 1989 IRIS assessment derived an RfD of 2 mg/kg/day based on a NOAEL for renal effects in a chronic rat dietary study (USEPA 1989e).

In 2010, ATSDR derived an intermediate MRL of 0.76 mg/kg/day based on the occurrence of an extra lumbar rib in mouse fetuses in the absence of observed maternal

toxicity and using benchmark dose modeling (ATSDR 2010). This MRL is designated as intermediate because it is based on developmental effects that occurred from less-than-chronic exposure. It is considered to be protective for chronic exposures because it is lower than the chronic RfD of 2 mg/kg/day developed in the 1989 IRIS assessment (USEPA 1989e). As MRLs and RfDs are derived through a generally similar process (that is, the application of appropriate UFs to a POD), MRLs are considered equivalent to RfDs for the purpose of ground water quality criteria calculations. Based on this updated toxicity factor, the Department is proposing to revise the criterion from 300 µg/L to 5,100 µg/L.

hh. Heptachlor: Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified heptachlor as Group B2, "probable human carcinogen" in 1987 (USEPA 1987a). The existing ground water quality criterion for heptachlor is based on a cancer slope factor of 4.5 $(mg/kg/day)^{-1}$, which is based on liver tumors in mice, derived in a 1987 IRIS assessment (USEPA 1987a). Based on the same mouse data as in the 1987 IRIS assessment, and using more current risk assessment approaches, CalEPA (1999b) derived a cancer slope factor of 4.1 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.008 µg/L to 0.0081 µg/L.

ii. Heptachlor epoxide: Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified heptachlor epoxide as Group B2, "probable human carcinogen" in 1987 (USEPA 1987b). The existing ground water quality criterion for heptachlor epoxide is based on a cancer slope factor of 9.1 $(mg/kg/day)^{-1}$, which is based on liver tumors in mice, derived in a 1987 IRIS assessment (USEPA 1987b).

Based on the same mouse data as in the 1987 IRIS assessment, and using more current risk assessment approaches, CalEPA (1999b) derived a cancer slope factor of 5.5 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.004 µg/L to 0.0061 µg/L.

jj. Hexachlorobenzene: Utilizing the USEPA's 1996 Proposed Guidelines for Carcinogen Risk Assessment (USEPA 1996), the USEPA classified hexachlorobenzene as Group B2, "probable human carcinogen" in 2015 (USEPA 2015). The existing ground water quality criterion for hexachlorobenzene is based on a cancer slope factor of 1.6 $(mg/kg/day)^{-1}$, which is based on liver tumors in rats derived in a 1989 IRIS assessment (USEPA 1989f). The 2015 USEPA Office of Water human health ambient water quality criteria for hexachlorobenzene (USEPA 2015) are based on a USEPA Office of Pesticide Programs Reregistration Eligibility Decision (USEPA 2008b). Based on the same rat data as in the 1989 IRIS assessment, and using more current risk assessment approaches, the Office of Pesticide Programs derived a cancer slope factor of 1.02 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.02 µg/L to 0.033 µg/L.

kk. Hexachlorobutadiene: Utilizing the USEPA's 1996 Proposed Guidelines for Carcinogen Risk Assessment (USEPA 1996), the USEPA classified hexachlorobutadiene as Group C, "possible human carcinogen" in 1987 (USEPA 1987c). The basis for the existing ground water quality criterion is increased incidence of kidney tumors in male rats, which was used by the USEPA's IRIS program to derive a cancer slope factor of 0.078 $(mg/kg/day)^{-1}$ (USEPA 1987c).

Using the same study as in the 1987 IRIS assessment, but using female rat kidney tumor data and more current carcinogen risk assessment approaches, the USEPA Office of Water developed a cancer slope factor of 0.04 $(mg/kg/day)^{-1}$ (USEPA 2003a). Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.4 µg/L to 0.8 µg/L.

ll. Hexachloroethane: The existing ground water quality criterion for hexachloroethane is based on a cancer slope factor of 0.014 $(mg/kg/day)^{-1}$ from a 1987 IRIS assessment. Since that time, the USEPA developed an updated IRIS assessment for hexachloroethane (USEPA 2011b). Based on the observation of increased incidence of renal adenomas/carcinomas combined in male rats, and more current carcinogen risk assessment approaches, the USEPA derived a cancer slope factor of 0.04 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 2 µg/L to 0.8 µg/L.

mm. Indeno(1,2,3-c,d)pyrene: The updated ground water quality criterion for indeno(1,2,3-c,d)pyrene is based on the updated IRIS assessment for benzo(a)pyrene (USEPA 2017). Based on USEPA guidance (USEPA 1993), the cancer slope factor for indeno(1,2,3-c,d)pyrene was derived from the benzo(a)pyrene cancer slope factor of 1 $(mg/kg/day)^{-1}$ with application of an "estimated order of potential potency" factor of 0.1 resulting in a cancer slope factor of 0.1 $(mg/kg/day)^{-1}$. Because carcinogenic PAHs such as indeno(1,2,3-c,d)pyrene have a mutagenic mode of action for carcinogenicity, the age-dependent adjustment factors are applied to the slope factor. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.05 µg/L to 0.1 µg/L.

nn. Methanol: The existing ground water quality criterion for methanol is based on the RfD of 0.5 mg/kg/day from a 1998 IRIS assessment. Since that time, the USEPA developed an updated IRIS assessment for methanol (USEPA 2013b). Based on the observation of extra cervical ribs in mice exposed during gestation, the USEPA derived an RfD of 1.9 mg/kg/day which is associated with less uncertainty than the earlier RfD. Based on this updated RfD, the Department is proposing to revise the criterion from 4,000 µg/L to 13,000 µg/L.

oo. Methoxychlor: Utilizing the USEPA's 1986 Guidelines for Carcinogen Risk Assessment (USEPA 1986a), the USEPA classified methoxychlor as Group D, "not classifiable as to human carcinogenicity" in 1990 (USEPA 1990d). The existing ground water quality criterion for methoxychlor is based on an RfD of 0.005 mg/kg/day, which is based on loss of litters in rabbits from a 1986 teratology study, derived in a 1990 IRIS assessment (USEPA 1990d).

CalEPA (2010) derived an Acceptable Daily Dose (equivalent to an RfD) of 0.00002 mg/kg/day based on increased prostate and seminal vesicle weights in the offspring of mice orally exposed in a 1999 study. Based on this updated RfD, the Department is proposing to revise the criterion from 40 µg/L to 0.1 µg/L.

pp. Methyl ethyl ketone (MEK) (2-Butanone): The existing ground water quality criterion for methyl ethyl ketone is based on the RfD of 0.039 mg/kg/day from a 1987 assessment by the NJDWQI (1987e). Since that time, the NJDWQI has developed an updated RfD for methyl ethyl ketone (NJDWQI 2009) based on a 2003 IRIS assessment (USEPA 2003b) that is associated with less uncertainty than the earlier 1987 NJDWQI assessment. Based on decreased rat pup body weight in a two-generation reproductive and developmental study using MEK's metabolic precursor, 2-butanol, an RfD of 0.639 mg/kg/day was derived. Based on this updated RfD, the Department is proposing to revise the criterion from 300 µg/L to 4,300 µg/L.

qq. Methylene chloride: The existing ground water quality criterion for methylene chloride is based on a cancer slope factor from a health-based MCL developed by the NJDWQI (1987f). Based on hepatocellular carcinomas and adenomas in male mice exposed via drinking water, the NJDWQI derived a cancer slope factor of 0.014 $(mg/kg/day)^{-1}$. The NJDWQI classified methylene chloride as a probable human carcinogen.

In 2011, IRIS derived a cancer slope factor of 0.002 $(mg/kg/day)^{-1}$ using the same data as the 1987 NJDWQI cancer slope factor (USEPA 2011a). However, it was derived using a tissue-specific dose metric from a physiologically based pharmacokinetic (PBPK) model to account for a sensitive population. Under the USEPA's 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005b), methylene chloride is "likely to be carcinogenic to humans" (USEPA 2011a). Based on a weight of evidence evaluation, the USEPA concluded that methylene chloride is carcinogenic by a mutagenic mode of action (USEPA 2011a). Because of this mutagenic mode of action for carcinogenicity, age-dependent adjustment factors are applied to the cancer slope factor of 0.002 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 3 µg/L to 6 µg/L.

rr. Nitrobenzene: The existing ground water quality criterion for nitrobenzene is based on the RfD of 0.0005 mg/kg/day from a 1991 IRIS assessment. Since that time, the USEPA developed an updated IRIS assessment for nitrobenzene (USEPA 2009a). Based on the

observation of increased methemoglobin in rats, the USEPA derived an RfD of 0.0018 mg/kg/day. While the USEPA (2009a) categorized nitrobenzene as "likely to be carcinogenic to humans" based on multiple tumor sites in rats and mice (USEPA 2009a), an oral cancer slope factor was not derived. Consistent with its policy for chemicals with evidence of human carcinogenic potential in the absence of an appropriate cancer slope factor, the Department applied an additional UF of 10 to address the potential for cancer risk in deriving the criterion based on the IRIS RfD of 0.0018 mg/kg/day. Based on this RfD, the Department is proposing to revise the criterion from 4 µg/L to 1.2 µg/L.

ss. Pentachlorophenol: The existing ground water quality criterion for pentachlorophenol is based on the cancer slope factor of 0.12 $(mg/kg/day)^{-1}$ from a 1991 IRIS assessment. The updated criterion is based on an updated IRIS assessment (USEPA 2009b). Based on liver and adrenal tumors in male rats, the USEPA derived a cancer slope factor of 0.4 $(mg/kg/day)^{-1}$. Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 0.3 µg/L to 0.08 µg/L.

tt. 1,1,2,2-Tetrachloroethane: The existing ground water quality criterion for 1,1,2,2-tetrachloroethane is based on an RfD from a Health-based MCL developed by the NJDWQI (1994). Based on liver toxicity (increased hepatic fat content) in rats exposed via inhalation in a 1972 study, the NJDWQI derived an RfD of 0.00014 mg/kg/day. As 1,1,2,2-tetrachloroethane was identified as a Group C (possible) carcinogen, this RfD includes an additional UF of 10 to account for potential carcinogenicity.

The NJDWQI (2009) later classified 1,1,2,2-tetrachloroethane as a suggestive carcinogen and revised its assessment to use a cancer slope factor of 0.2 $(mg/kg/day)^{-1}$ developed by IRIS (later posted on the IRIS database as USEPA 2010c). This slope factor was based on liver tumors in female mice exposed via gavage in a 1978 study. Under a revised Department approach for Group C/suggestive carcinogens adopted in 2000, criteria are derived based on the 10^{-6} cancer risk level when a scientifically supportable cancer slope factor is available, and an RfD with an additional UF of 10 to account for potential carcinogenicity is used when such a cancer slope factor is not available. Therefore, based on the cancer slope factor of 0.2 $(mg/kg/day)^{-1}$, the Department is proposing to revise the criterion from 1 µg/L to 0.2 µg/L.

uu. Tetrahydrofuran: The existing ground water quality criterion for tetrahydrofuran is based on the RfD of 0.02 mg/kg/day from a 2000 USEPA Region 3 Regional Risk Screening Level with an additional UF of 10 based on Department policy for contaminants with evidence of human carcinogenic potential in the absence of an appropriate cancer slope factor. Since that time, the USEPA developed an updated IRIS assessment for tetrahydrofuran (USEPA 2010d). Based on the observation of decreased rat pup body weight, the USEPA derived an RfD of 0.93 mg/kg/day. While the USEPA categorized tetrahydrofuran as having "suggestive evidence of carcinogenic potential" based on liver tumors in female

mice and renal tumors in male rats (USEPA 2010d), an oral cancer slope factor was not derived. Consistent with its policy for chemicals with evidence of human carcinogenic potential in the absence of an appropriate cancer slope factor, the Department applied an additional UF of 10 to address the potential for cancer risk in deriving the criterion based on the IRIS RfD of 0.93 mg/kg/day, resulting in an RfD of 0.093 mg/kg/day. Based on this updated RfD, the Department is proposing to revise the criterion from 10 µg/L to 620 µg/L.

vv. 1,2,4-Trichlorobenzene: Utilizing the USEPA's 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005b), the USEPA classified 1,2,4-trichlorobenzene as "likely to be carcinogenic to humans" by the oral route of exposure based on a finding of increased tumor incidence in more than one sex of mouse in 2009 (USEPA 2009d). The USEPA's IRIS program has not derived a cancer slope factor for 1,2,4-trichlorobenzene. The existing ground water quality criterion for 1,2,4-trichlorobenzene is based on an RfD of 0.0012 mg/kg/day from a health-based MCL developed by the NJDWQI (1987g). This RfD is based on increased urinary excretion of porphyrins in rats from a 1978 subchronic inhalation study.

In 2009, the NJDWQI reevaluated 1,2,4-trichlorobenzene and developed an RfD of 0.0026 mg/kg/day based on distended abdomens and increased liver weight in mice from a 1994 chronic oral study (NJDWQI 2009). With this reevaluation, the NJDWQI classified 1,2,4-trichlorobenzene as a suggestive carcinogen. Consistent with the NJDWQI policy for contaminants with evidence of human carcinogenic potential that do not have a cancer slope factor, an additional UF of 10 was used in deriving the RfD. As discussed in the NJDWQI (2009) assessment, the USEPA's IRIS program derived an RfD of 0.01 mg/kg/day based on adrenal effects from a subchronic rat study (USEPA 1992b). The NJDWQI (2009) ultimately concluded that the IRIS RfD was not the most appropriate basis, as no chronic studies were available when the 1992 IRIS RfD was developed.

Also in 2009, a PPRTV assessment (USEPA 2009d) derived a cancer slope factor of 0.029 $(mg/kg/day)^{-1}$ based on liver tumors in male mice orally exposed. Based on this updated cancer slope factor of 0.029 $(mg/kg/day)^{-1}$, the Department is proposing to revise the criterion from 9 µg/L to 1.1 µg/L.

ww. 1,1,1-Trichloroethane: The existing ground water quality criterion for 1,1,1-trichloroethane is based on an RfD of 0.0037 mg/kg/day from a health-based MCL developed by the NJDWQI (1987h). This RfD is based on liver toxicity in mice exposed via inhalation for 14 weeks. In a 2007 IRIS assessment (USEPA 2007a), the USEPA derived an RfD of 2 mg/kg/day based on decreased body weight gain in female mice. Utilizing the USEPA's 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005b), IRIS determined in 2007 that there is "inadequate information to assess the carcinogenic potential" of 1,1,1-trichloroethane (USEPA 2007a).

In 2009, the NJDWQI reevaluated 1,1,1-trichloroethane and developed an RfD of 0.28 mg/kg/day based on decreased body weight gain in male mice exposed via microcapsules in feed for 13 weeks from the same principal study as the 2007 IRIS assessment (NJDWQI 2009). Although based on the same endpoint (body weight gain) and principal study, the 2007 IRIS assessment based its RfD on female mice which were less sensitive than males to the body weight effects of 1,1,1-trichloroethane. The 2009 NJDWQI RfD, based on a study with oral exposure, is also preferable to the 1987 NJDWQI RfD, which was based on an inhalation study. Based on the updated RfD of 0.28 mg/kg/day developed by the NJDWQI, the Department is proposing to revise the criterion from 30 µg/L to 1,900 µg/L.

xx. 1,1,2-Trichloroethane: The existing ground water quality criterion for 1,1,2-trichloroethane is based on an RfD of 0.00039 mg/kg/day from a health-based MCL developed by the NJDWQI (1994), which is based on changes in liver enzymes and clinical chemistry parameters as well as alterations in immune response. The NJDWQI classified 1,1,2-trichloroethane as a Group C carcinogen. Consistent with Department policy for Group C (possible human carcinogen) contaminants, an additional UF of 10 to account for potential carcinogenicity was used in deriving the RfD.

Under a revised Department approach for Group C/suggestive carcinogens adopted in 2000, criteria are derived at the 10^{-6} cancer risk level when a cancer slope factor is available, and an RfD with an additional UF of 10 to account for potential carcinogenicity is used when a slope factor is not available. The NJDWQI (2009) reevaluated 1,1,2-trichloroethane and classified it as a suggestive human carcinogen. The updated NJDWQI assessment is based on a cancer slope factor of 0.057 $(mg/kg/day)^{-1}$ for liver tumors in male mice from a 1986 IRIS assessment (USEPA 1986b). Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 3 µg/L to 0.58 µg/L.

yy. Trichloroethylene: The existing ground water quality criterion for trichloroethylene is based on a cancer slope factor from a health-based MCL developed by the NJDWQI (1987i). Based on liver tumors in male and female mice exposed via gavage in a 1984 study, the NJDWQI derived a cancer slope factor of 0.031 $(mg/kg/day)^{-1}$. The NJDWQI classified trichloroethylene as a probable human carcinogen.

In 2011, IRIS derived a cancer slope factor of 0.046 $(mg/kg/day)^{-1}$ using a physiologically based pharmacokinetic (PBPK) model for route-to-route extrapolation of the inhalation unit risk estimate for kidney cancer (in adult workers exposed via inhalation as reported in studies from 2003 and 2006) with a factor of 5 applied to include non-Hodgkin's lymphoma and liver cancer risks, and combined risks (USEPA 2011c).

Under the USEPA's 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005b), trichloroethylene was characterized by the USEPA as "carcinogenic to humans" by all routes of exposure (USEPA 2011c). Based on a weight of evidence evaluation, the

USEPA concluded that trichloroethylene is carcinogenic by a mutagenic mode of action for induction of kidney tumors (USEPA 2011c). Because of this mutagenic mode of action for carcinogenicity, age-dependent adjustment factors are applied to the cancer slope factor of 0.046 $(mg/kg/day)^{-1}$. Based on this cancer slope factor, the Department is proposing to revise the criterion from 1 µg/L to 0.28 µg/L.

zz. 2,4,6-Trichlorophenol: The existing ground water quality criterion for 2,4,6-trichlorophenol is based on classification as B2, probably human carcinogen and a cancer slope factor of 0.026 $(mg/kg/day)^{-1}$ from an assessment by the NJDWQI (1994). Since that time, the NJDWQI has classified 2,4,6-trichlorophenol as a likely human carcinogen and developed an updated assessment for 2,4,6-trichlorophenol (NJDWQI 2009) based on a cancer slope factor of 0.011 $(mg/kg/day)^{-1}$ for increased incidence of leukemia in male rats from a 1990 IRIS assessment (USEPA 1990e). Based on this updated cancer slope factor, the Department is proposing to revise the criterion from 1 µg/L to 3.0 µg/L.

aaa. Vinyl chloride: The existing criterion for vinyl chloride is based on a cancer slope factor from a health-based MCL developed by the NJDWQI (1987j). Based on hepatocellular carcinoma incidence in female rats exposed orally in a 1981 study, the NJDWQI derived a cancer slope factor of 0.42 $(mg/kg/day)^{-1}$ using a linearized multistage model, and interspecies extrapolation was based on the rat-to-human body weight ratio to the 2/3 power. The NJDWQI classified vinyl chloride as a human carcinogen (Group A).

The NJDWQI (2009) developed an updated assessment of vinyl chloride based on an updated cancer slope factor of 1.5 $(mg/kg/day)^{-1}$. This updated cancer slope factor is based on a 2000 IRIS assessment (USEPA 2000b) that reevaluated the same rat data from the 1981 study used for the 1987 NJDWQI cancer slope factor. In this reevaluation, the USEPA used more current carcinogen risk assessment approaches to model the combined incidence of liver angiosarcomas, hepatocellular carcinomas, and precursor liver nodules in female rats. To account for interspecies extrapolation, the USEPA used a physiologically-based pharmacokinetic (PBPK) model. As the carcinogenicity of vinyl chloride increases with continuous lifetime exposure from birth, a twofold UF for increased risk from early life exposure was also incorporated into the cancer slope factor. Under the USEPA's 2005 Guidelines for Carcinogen Risk Assessment (USEPA 2005b), vinyl chloride is characterized as "carcinogenic to humans" (NJDWQI 2009). Based on the updated cancer slope factor of 1.5 $(mg/kg/day)^{-1}$, the Department is proposing to revise the criterion from 0.08 µg/L to 0.022 µg/L.

4.2 Practical Quantitation Level (PQL) Updates

The PQL and the method detection limit (MDL) are performance measures used to estimate the limits of performance of analytical chemistry methods for measuring contaminants. The MDL is defined as "the minimum concentration of a substance that can be measured and reported with

99% confidence that the analyte concentration is greater than zero" (40 CFR Part 136 Appendix B). The USEPA recommends that the MDL be multiplied by a factor of five or ten to account for the variability and uncertainty that can occur at the MDL. Establishing the PQL at a level that is five times the MDL provides a reliable quantitation level that most laboratories can be expected to meet during day-to-day operations. Pursuant to N.J.A.C. 7:9C-1.9(c)3ii, the Department establishes PQLs for Class II ground water constituents in two ways:

1. PQLs derived from Method Detection Limit (MDL) data from the New Jersey Department of Health and Senior Services Laboratory (DHSS) multiplied by 5; or

2. PQLs derived from laboratory performance data that has been evaluated by the Department using the method of Sanders, Lippincott and Eaton (See Sanders, P. et al., "Determining Quantitation Levels for Regulatory Purposes." J. Amer. Water Works Assoc., 1996, March pp. 104-114).

The first option (i.e., utilizing MDL data from the New Jersey DHSS laboratory) is preferred unless the necessary data are unavailable, the data provided were not obtained using the most sensitive analytical method, or the New Jersey DHSS laboratory is not certified for the constituent. Sufficient MDL data were not available from the New Jersey DHSS laboratory to calculate PQLs. Therefore, many PQLs were derived using interlaboratory performance data. When sufficient interlaboratory performance data were available, the PQLs were established as either the median MDL multiplied by five or the Reporting Limit (RL).

Additionally, the State reserves the right to consider values as equivalent to calculated PQLs if quantitation values, such as minimum levels (MLs) in USEPA 1600 series methods, Contract Required Quantitation Levels (CRQLs) as in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) methods, or Lowest Concentration Minimum Reporting Levels (LCMRLs) in more recent USEPA methods, are listed in published analytical methods databases or peer-reviewed literature or are otherwise mandatory by state or federal contractual engagement requirements (N.J.A.C. 7:9C-1.4). Therefore, when interlaboratory performance data were unavailable for a constituent, PQLs were developed using the published MDL data in the USEPA analytical method document or the National Environmental Methods Index. When these published MDL data were utilized, the PQL was established as the MDL multiplied by five or the median of the low point calibration data.

As shown earlier in Table A, 38 PQLs are proposed to be updated in Appendix Table 1 of the rules to ensure that they reflect the best available science. Proposed updated PQLs and the associated analytical methods are presented in Table C below. All PQLs listed in Table C were derived according to N.J.A.C. 7:9C-1.9(c)3ii.

Table C: Practical Quantitation Levels (PQLs) and Analytical Methods

Constituent	CASRN	Current PQL (ug/L)	Proposed PQL (ug/L)	Derivation	Analytical Method
Acrolein	107-02-8	5	4.4*	MDLx5 [1]	USEPA 603
Aldrin	309-00-2	0.04	0.020*	median lowpt	USEPA 1699
Benzene	71-43-2	1	0.45*	MDLx5 [1]	USEPA 524.4 SIM
Benzidine	92-87-5	20	6.6*	MDLx5 [1]	USEPA 605
beta-BHC (beta-HCH)	319-85-7	0.04	0.020	median lowpt	USEPA 1699
1,1-Biphenyl (Diphenyl)	92-52-4	10	5.0*	median lowpt	USEPA 642
Bromodichloromethane (Dichlorobromomethane)	75-27-4	1	0.50	median lowpt	USEPA 524.2
Chlordane	57-74-9	0.5	0.20*	median lowpt	USEPA 1699
4-Chloroaniline (p-Chloroaniline)	106-47-8	10	5.0*	median lowpt	USEPA 1625C
4-Chloro-3-methylphenol, (3-methyl-4-chlorophenol)	59-50-7	generic	0.18	MDLx5 [2]	USEPA 528
Cobalt	7440-48-4	0.5	0.45	NEMI	USEPA 200.8
Cyanide (free cyanide)	57-12-5	6	5.0*	median lowpt	USEPA 335.4
Dibromochloromethane (Chlorodibromomethane)	124-48-1	1	0.75	median lowpt	USEPA 601
3,3'-Dichlorobenzidine	91-94-1	30	5.2*	MDLx5 [1]	USEPA 605
1,2-Dichloroethane	107-06-2	2	0.060	MDLx5 [2]	USEPA 524.4 SIM
1,2-Dichloropropane	78-87-5	1	0.50	median lowpt	USEPA 524.4 SIM
1,3-Dichloropropene (cis- and trans-)	542-75-6	1	0.45*	MDLx5 [1]	USEPA 524.4 SIM
Dieldrin	60-57-1	0.03	0.020*	median lowpt	USEPA 1699
Dimethyl phthalate	131-11-3	generic	0.29	MDLx5 [2]	USEPA 525.2
2,4-Dinitrophenol	51-28-5	40	10	median lowpt	USEPA 528
2,4-Dinitrotoluene/2,6-Dinitrotoluene mixture	25321-14-6	10	5.2*	MDLx5 [1]	USEPA 529
1,2-Diphenylhydrazine	122-66-7	20	2.2*	MDLx5 [1]	USEPA 526
Heptachlor	76-44-8	0.05	0.020*	median lowpt	USEPA 1699
Heptachlor epoxide	1024-57-3	0.2	0.020*	median lowpt	USEPA 1699
Hexachloroethane	67-72-1	7	0.65	median lowpt	USEPA 524.2
Nitrobenzene	98-95-3	6	0.075	MDLx5 [2]	USEPA 526

Constituent	CASRN	Current PQL (ug/L)	Proposed PQL (ug/L)	Derivation	Analytical Method
N-Nitrosodi-n-propylamine	621-64-7	10	1.6*	NEMI	USEPA 521
PCBs (Polychlorinated biphenyls)	1336-36-3	0.5	0.20*	MDLx5 [2]	USEPA 525.2
Perfluorononanoic acid (PFNA)	375-95-1	0.005	0.0025	MDLx5 [1]	USEPA 537
1,1,2,2-Tetrachloroethane	79-34-5	1	0.065	MDLx5 [2]	USEPA 524.3
Tetrachloroethylene (PCE)	127-18-4	1	0.055	MDLx5 [2]	USEPA 524.4 SIM
Thallium (Total)	7440-28-0	2	0.50	MDLx5 [2]	USEPA 200.8
Toxaphene	8001-35-2	2	1.2*	MDLx5 [2]	USEPA 608
1,1,2-Trichloroethane	79-00-5	2	0.24	MDLx5 [2]	USEPA 524.3
Trichloroethylene (TCE)	79-01-6	1	0.10	NEMI	USEPA 524.2
2,4,6-Trichlorophenol	88-06-2	20	0.23	MDLx5 [2]	USEPA 528
1,2,3-Trichloropropane	96-18-4	0.03	0.0050*	RL	USEPA 524.3 SIM
Vinyl chloride	75-01-4	1	0.035*	MDLx5 [2]	USEPA 524.4 SIM

Table C Footnotes:

New PQLs are marked with an **(*)** when the ground water quality standard for the constituent is PQL driven (that is, PQL > criterion).

[1]Interlaboratory performance data was utilized to calculate MDL.

[2]MDL from USEPA method document was utilized to calculate PQL due to insufficient availability of laboratory performance data.

Table C Notes:

CASRN = Chemical Abstracts Service Registry Number is a unique numerical identifier assigned to every chemical substance described in the open scientific literature.

MDLx5 = Method Detection Limit multiplied by 5.

Median lowpt = Median of low point calibration data. PQLs can be generated from the median of low point calibration data submitted by laboratories following the method of Sanders, Lippincott and Eaton in accordance with N.J.A.C. 7:9c-1.9(c)3ii(2).

NEMI = Method Detection Limit (MDL) data obtained from the National Environmental Methods Index

RL = Reporting Limit. PQLs can be generated from the quantitated reporting limits submitted by laboratories or as reported in approved analytical methods.

SIM = Selected Ion Monitoring

For information about the bases for previous PQL recommendations, see the 2017 Basis and Background for Criteria Derivation and Practical Quantitation Levels (https://www.nj.gov/dep/wms/bears/docs/gwqsbb2017final.pdf) and the 2004 Basis and Background document (https://www.nj.gov/dep/wms/bears/docs/gwqsbb2004.pdf).

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