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ENVIRONMENTAL PROTECTION

SITE REMEDIATION AND WASTE MANAGEMENT

Remediation Standards

Proposed New Rules and Repeals: N.J.A.C. 7:26D-4.2 and 4.3; and 7:26D Appendices 1 through 6

Proposed Amendments: N.J.A.C. 7:26D-1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 3.1, 3.2, 4.1, 5.1, 5.2, 5.3, 6.1, 6.2, 7.1, 7.2, and 7.4; and 7:26E-1.5

Proposed New Rules: N.J.A.C. 7:26D-4.4, 5.1, 5.2, 7.2, 8.1, 8.3, and 8.5, and 7:26D Appendices 7 through 12

Proposed Repeals: N.J.A.C. 7:26D-6.2, 7.1, 7.3, and 7.5

Authorized By: Catherine R. McCabe, Commissioner, Department of Environmental Protection.

Authority: N.J.S.A. 13:1D-1 et seq., 58:10-23.11a et seq., 58:10A-1 et seq., and 58:10B-1 et seq.

Calendar Reference: See Summary below for explanation of exception to calendar requirement.

DEP Docket Number: 01-20-03.

Proposal Number: PRN 2020-034.

The Department anticipates holding a **public hearing** on the proposal. The date and time of the hearing will depend on circumstances surrounding the COVID-19 public health emergency. If the Department holds a hearing, the public comment period will be extended until after the hearing.

Further information on a public hearing, if one is held, will be posted on the

Department's website at www.nj.gov/dep/rules/notices.html at least 15 days prior to the date of the hearing. Notice will also be sent to those who have subscribed to the Department's rulemaking listserv. To subscribe, go to www.nj.gov/dep/rules/subscribe.html.

Written comments may also be submitted at the public hearing. It is requested (but not required) that anyone who testifies at the public hearing provide a copy of their comments to the stenographer at the hearing.

Submit comments by June 5, 2020, electronically at http://www.nj.gov/dep/rules/comments. The Department of Environmental Protection (Department) encourages electronic submittal of comments. In the alternative, comments may be submitted on paper to:

Alice A. Previte, Esq.

Attn: DEP Docket Number: 01-20-03

Office of Legal Affairs

Department of Environmental Protection

401 East State Street, 7th Floor

Mail Code 401-04L

PO Box 402

Trenton, New Jersey 08625-0402

This notice of proposal may be viewed or downloaded from the Department's website at

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http://www.nj.gov/dep/rules.

The agency proposal follows:

Summary

As the Department has provided a 60-day comment period on this notice of proposal, this notice is excepted from the rulemaking calendar requirement pursuant to N.J.A.C. 1:30-3.3(a)5.

Overview

The Brownfield and Contaminated Site Remediation Act (Brownfield Act) at N.J.S.A. 58:10B-12 requires the Department to develop remediation standards for soil, ground water, and surface water quality necessary for the remediation of contamination of real property. Under the Brownfield Act, these standards must be protective of public health and safety, and the environment. The remediation standards apply to contaminated sites throughout the State. The Department reviewed its existing Remediation Standards at N.J.A.C. 7:26D to determine whether the standards continue to satisfy the requirements of the Brownfield Act. As a result of its review, and as discussed in further detail below, the Department is proposing to amend N.J.A.C. 7:26D in a variety of ways, including:

- Replacement of the development of site-specific soil remediation standards for the impact to ground water exposure pathway with codified soil and soil leachate remediation standards for the migration to ground water exposure pathway, which

establishes a stronger basis for the Department to enforce the regulated community's compliance with promulgated remediation standards, as compared to existing screening levels that need to be established as site-specific standards for contaminated sites;

- Addition of indoor air remediation standards for the vapor intrusion pathway, codified to establish a basis for enforceability as promulgated standards, instead of screening levels, which are not legally enforceable;
- Replacement of direct contact soil remediation standards with separate soil remediation standards for the inhalation exposure pathway and the ingestion-dermal exposure pathway;
- Expansion of the existing interim remediation standard process at N.J.A.C. 7:26D-5 to include soil and soil leachate for the migration to ground water exposure pathway, indoor air, and ground water;
- Expansion of the existing updating remediation standards process at N.J.A.C. 7:26D-6 to include soil and soil leachate for the migration to ground water exposure pathway, indoor air, and ground water;
- Expansion of the existing alternative remediation standards process at N.J.A.C. 7:26D-7 to include soil and soil leachate for the migration to ground water exposure pathway and indoor air;
- Deletion of remediation standards for existing chemicals and addition of remediation standards for new chemicals based upon routine detection, routine analysis, and available toxicity information;

- Use of updated toxicity factors, exposure assumptions, and chemical and physical factors, resulting in some numerical changes to the existing remediation standards; and
- Added definitions of "residential" and "nonresidential" based on property use.

Proposed new and amended N.J.A.C. 7:26D-1 through 8 establish the remediation standards for various media and exposure pathways, in part by incorporating by reference the numeric standards established in the relevant appendices (or portions of appendices). Proposed new N.J.A.C. 7:26D Appendix 1 contains tables of remediation standards for the various media and exposure pathways. Proposed new N.J.A.C. 7:26D Appendices 2 through 7 provide the procedures and equations that the Department used to develop the proposed remediation standards in N.J.A.C. 7:26D Appendix 1. Proposed new N.J.A.C. 7:26D Appendices 8 and 9 provide the methodology that the Department will use to develop alternative remediation standards. Proposed new N.J.A.C. 7:26D Appendices 10 and 11 contain the chemical and physical properties of contaminants and the toxicity factors for the contaminants. Proposed new N.J.A.C. 7:26D Appendix 12 demonstrates the equivalency between the equations used to develop the proposed soil and indoor air remediation standards and the equations the United States Environmental Protection Agency (USEPA) used in its Regional Screening Levels when it developed soil and indoor air risk-based screening levels.

The proposed rules provide remediation standards for various media and exposure pathways, including some that are not in the existing rules. For ground water and surface water, like the existing rules, the proposed rules use the existing Ground Water Quality Standards,

N.J.A.C. 7:9C, and the Surface Water Quality Standards, N.J.A.C. 7:9B, as the remediation standards. The Department is changing the way it approaches the soil remediation standards, however. In the existing rules, the Department developed, for a given contaminant, a health-based soil criterion for both the ingestion-dermal and soil inhalation exposure pathways. The Department selected the more stringent health-based soil criterion as the direct contact human health-based soil remediation standard. The proposed rules establish separate health-based soil remediation standards for both the ingestion-dermal exposure pathway and the inhalation exposure pathway.

The existing rules do not provide an impact to ground water soil remediation standard. Instead, using its authority under the Brownfield Act, N.J.S.A. 58:10B-12, the Department establishes soil remediation standards for impact to ground water on a case-by-case basis, based upon the criteria in the Brownfield Act. The Department provides guidance in the form of Technical Guidance documents prepared by the Department to assist in establishing the appropriate impact to ground water standards for various sites. These Technical Guidance documents are found on the Department's website at: https://www.nj.gov/dep/srp/guidance/rs/index.html. The Technical Guidance document entitled "Development of Impact to Ground Water Soil Remediation Standards Using the Soil-Water Partition Equation" (Version 2.0 – November 2013) contain soil screening levels for contaminants.

In contrast, the proposed rules codify remediation standards for soil and soil leachate for the migration to ground water exposure pathway, based upon migration of contaminants to

ground water and subsequent human ingestion of ground water. The Department is proposing to codify existing soil and soil leachate screening levels contained in Department guidance as remediation standards to establish a basis for enforceability as promulgated standards.

The Department is proposing to add remediation standards for indoor air, based on vapor intrusion. The existing rules do not address indoor air. The proposed standards are for volatile hazardous substances resulting from a discharge that is found in ground water and has the potential to volatilize from the ground water, migrate through soil as part of soil gas, and infiltrate buildings.

Additionally, the existing rules address interim remediation standards for soil (direct contact) and a process for updating direct contact soil remediation standards. The proposed rules expand the existing rules to provide for interim remediation standards and updating remediation standards for soil (migration to ground water), soil leachate, ground water, and indoor air. The existing rules provide for alternative remediation standards, a process by which the person responsible for conducting the remediation may request to use a remediation standard other than the direct contact soil remediation standard provided in the rules. The proposed rules expand the existing rules to allow a person responsible to request an alternative remediation standard for soil (migration to ground water), soil leachate, and indoor air.

At proposed new N.J.A.C. 7:26D Appendix 1, which contains tables of numeric remediation standards, the Department is including new soil remediation standards for 12 chemicals that are on the USEPA Target Compound List. These are chemicals that laboratories have routinely analyzed and reported, that have been detected in New Jersey, and for which

toxicity information exists. As discussed in the "Appendix 1" section of the Summary below, the Department also proposes soil remediation standards for some other contaminants that are not identified in existing rules. Existing remediation standards for several contaminants are based on toxicity information that the USEPA no longer supports, and for which reliable toxicity information is not available. The Department is not proposing remediation standards for these contaminants. The Department is also not proposing remediation standards for several contaminants that are rarely found at contaminated sites in New Jersey. The Department is proposing to codify existing soil and soil leachate screening levels in Department guidance as remediation standards.

The Department also proposes to add definitions and amend rule language throughout N.J.A.C. 7:26D for consistency and clarity, to update cross-references, and to correct punctuation and grammar.

Outside of this rulemaking, but related to the proposed remediation standards, the Department is amending existing technical guidance and developing new technical guidance documents to assist the regulated community in applying the remediation at contaminated sites.

Stakeholder process

In developing the proposed rules, the Department met with stakeholders, including members of Department programs affected by the Remediation Standards, the New Jersey Department of Health, the Licensed Site Remediation Professional Association, the New Jersey Business and Industry Association, the Commerce and Industry Association of New Jersey, the Site Remediation Industry Network, and representatives of environmental groups,

environmental justice advocates, county planners, municipalities, and other associations. The records of those meetings are available on the Site Remediation Program Stakeholder Process, Remediation Standards, page of the Department's website, https://www.nj.gov/dep/srp/srra/stakeholder/. The Department considered the suggestions and recommendations of the stakeholders in preparing the proposed rules.

The notice of proposal Summary below first discusses the proposed new and amended rule text, and then the proposed new appendices.

Amendments to the General Information, N.J.A.C. 7:26D-1

N.J.A.C. 7:26D establishes remediation standards and provides mechanisms for developing interim remediation standards, updating existing remediation standards, and developing alternative remediation standards.

Proposed amended N.J.A.C. 7:26D-1.1, Purpose, identifies the specific remediation standards in the chapter, which are ground water, surface water, soil, soil leachate, and indoor air. Remediation standards for indoor air are new, as discussed further below. Therefore, indoor air is added throughout the chapter where the rules provide a list of contaminated media to be remediated. Existing N.J.A.C. 7:26D-1.1(a) refers to the standards in the chapter as "minimum" standards for remediation. The remediation standards in the chapter are not necessarily minimum requirements, as an alternative remediation standard established pursuant to proposed amended N.J.A.C. 7:26D-8 may allow a contaminant concentration that is less stringent than the "minimum" remediation standard. The remediation standards contained in

N.J.A.C. 7:26D Appendix 1 of the proposed rules are better described as "default" standards, since they are the standards that remediating parties must meet if an alternative remediation standard is not developed. For this reason, the Department proposes to remove references to the term "minimum" throughout the chapter.

The existing rules do not provide a codified impact to ground water soil remediation standard; rather, the Department develops the standard on a site-by-site basis. Because the proposed amended rules establish a remediation standard for the migration to ground water exposure pathway, existing N.J.A.C. 7:26D-1.1(b) is no longer applicable and is proposed to be deleted. Further, the Department proposes to delete N.J.A.C. 7:26D-1.1(c). The reference to the Technical Requirements for Site Remediation (Technical Requirements), N.J.A.C. 7:26E, is a simple declarative statement that the Remediation Standards, N.J.A.C. 7:26D, supplement the Technical Requirements. N.J.A.C. 7:26D-1.1(c) is not a regulatory requirement, and its inclusion at N.J.A.C. 7:26D is not necessary. Proposed amendments remove references to the deleted subsections throughout the chapter.

N.J.A.C. 7:26D-1.2 explains the scope of the chapter. Existing N.J.A.C. 7:26D-1.2(a) refers to remediation of various media, including ground water, surface water, and soil. Remediation is necessary only because of the contamination in the media; in the absence of contamination, there is no need to remediate. Accordingly, proposed amended N.J.A.C. 7:26D-1.2 refers to remediating the contaminants, rather than the media. The Department proposes to add the word "remediation" to N.J.A.C. 7:26D-1.2(b) to clarify that the standards in the chapter are remediation standards.

The applicability of the chapter is described at N.J.A.C. 7:26D-1.4. Existing N.J.A.C. 7:26D-1.4(b) cites to the Technical Requirements at N.J.A.C. 7:26E-1.5(c), which provides a phase-in period for the application of the Remediation Standards. The Department has determined that this phase-in language is better placed within N.J.A.C. 7:26D, to which it directly applies; therefore, the Department proposes to delete N.J.A.C. 7:26D-1.4(b) and 7:26E-1.5(c)2. Proposed new N.J.A.C. 7:26D-1.4(b) provides for a six-month phase-in period for the application of remediation standards. Historically, the Department has provided a six-month phase-in period for implementation of new remediation requirements. Particularly, when the Remediation Standards were adopted as new rules, effective June 2, 2008, the Department provided in the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-1.5(c) that sites must be remediated in accordance with the standards at N.J.A.C. 7:26D unless a remediation action workplan or remedial action report containing standards or criteria developed under the Brownfield Act had been submitted to the Department before December 2, 2008 (that is, prior to expiration of a six-month phase-in period; see N.J.A.C. 7:26E-1.5(c)2). To make clear that a similar phase-in period has applied to other amendments of the remediations standards and to explicitly provide a similar six-month phase-in period for the amendments proposed at this time, proposed new N.J.A.C. 7:26D-1.4(b) addresses which rules are applied in periods after the remediation standards are amended.

Proposed N.J.A.C. 7:26D-1.4(b)1 contains the language from the Technical Requirements at existing N.J.A.C. 7:26E-1.5(c)2 explaining when the person responsible for conducting the remediation may use site-specific remediation standards established prior to the adoption of

this chapter on June 2, 2008. As a result of the proposed codification of this provision at proposed N.J.A.C. 7:26D-1.4(b), the Department proposes to delete N.J.A.C. 7:26E-1.5(c)2 in the Technical Requirements, as it is no longer necessary.

Proposed new N.J.A.C. 7:26D-1.4(b)2 establishes the conditions under which the person responsible for conducting the remediation may use the remediation standards that were in effect from the initial date of the chapter, June 2, 2008, until the September 17, 2017, update of several of the remediation standards. Proposed new N.J.A.C. 7:26D-1.4(b)3 establishes the conditions under which the person responsible for conducting the remediation may use the remediation standards that were in effect after the September 17, 2017, update, but before the operative date these proposed amendments. For example, if the operative date of the proposed rules is July 1, 2020, any site for which a remedial action workplan or remedial action report is submitted prior to December 31, 2020 (less than six months after the operative date of the amendments), may be remediated using the remediation standards that were in effect prior to July 1, 2020, provided the conditions of N.J.A.C. 7:26D-1.4(b)3 are met. If the Department receives a remedial action workplan or a remedial action report on or after January 1, 2021 (six months or more after the operative date of the amendments), the new remediation standards apply to the remediation. The phase-in period does not apply, however, when the Department adopts a new remediation standard that is an order of magnitude or more stringent than the prior remediation standard.

As provided in the Brownfield Act at N.J.S.A. 58:10B-12j, the Department cannot compel the use of a newly promulgated remediation standard at a site that has an approved remedial

action workplan unless the new remediation standard is more stringent than the remediation standard approved in the remedial action workplan or other plan by an order of magnitude or more. As also provided in the Brownfield Act at N.J.S.A. 58:10B-13e, the Department cannot compel the use of a newly promulgated remediation standard at a site that has been issued a final remediation document unless the new remediation standard is more stringent than the remediation standard approved in the final remediation document by an order of magnitude or more, and the difference between the new remediation standard and the level or concentration of a contaminant at the site differs by an order of magnitude or more. In those cases, the Brownfield Act at N.J.S.A. 58:10B-12j mandates that the new remediation standard must be used.

Proposed remediation standards that are impacted by the order of magnitude provision in the Brownfield Act are set forth in the table below and are further discussed in the Economic Impact below.

Medium	Exposure Pathway	Scenario	Contaminant
Soil	Ingestion-dermal	Residential	Benzaldehyde and cobalt
Soil	Ingestion-dermal	Nonresidential	Benzaldehyde and butylbenzylphthalate
Soil	Inhalation	Residential	Caprolactum and ethylbenzene

Soil	Inhalation	Nonresidential	Caprolactum and ethylbenzene
Soil	Migration to ground water	n/a	hexachlorocyclopentadiene
Indoor air	Vapor intrusion	Residential	1,1-Dichloroethene (1,1-dichloroethylene)
Indoor air	Vapor intrusion	Nonresidential	1,1-Dichloroethene (1,1-dichloroethylene)

Definitions of terms used in the chapter are at N.J.A.C. 7:26D-1.5. Proposed new and amended definitions are discussed below and also in the discussion of the section where the defined term is used.

The Department is proposing to define “criterion” or “criteria” as the health-based values that are derived from the equations located at N.J.A.C. 7:26D Appendices 2, 3, and 5 for the ingestion-dermal, inhalation, and vapor intrusion exposure pathways, and soil-water partitioning values that are derived from the equations at N.J.A.C. 7:26D Appendix 4, equations 1 through 4 for the migration to ground water exposure pathway.

An “exposure pathway” is the method by which humans can come into contact with contamination. The existing definition provides ingestion-dermal and inhalation as two examples of exposure pathways. The proposed amended definition identifies the contaminants

as being present in soil, water, and other media, and adds as examples of exposure pathways the migration to groundwater and vapor intrusion exposure pathways.

As discussed below, the Department is proposing soil remediation standards at new N.J.A.C. 7:26D Appendix 1, Tables 1 through 4 for several contaminants that do not have existing soil remediation standards, including extractable petroleum hydrocarbons, which are contaminants found at many sites. The Department is proposing a new definition of "Extractable petroleum hydrocarbons" or "EPH" to specify that, as used in this chapter, this term refers to extractable aliphatic and aromatic petroleum hydrocarbons determined using the Department's "Extractable Petroleum Hydrocarbons Methodology". The proposed definition specifies that EPH includes, but is not limited to, No. 2 heating oil, diesel fuel, and heavier petroleum products, but excludes the lighter petroleum products including gasoline and light petroleum distillates.

The proposed amended definition of "ground water" corrects the citation to the definition of "ground water" in the Ground Water Quality Standards at N.J.A.C. 7:9C-1.4. The proposed definition does not include the phrase "which includes Class I, Class II, and Class III ground water," which is part of the existing definition, as the phrase is not contained in the definition of "ground water" in the Ground Water Quality Standards. For similar reasons, the Department proposes to amend the definition of "ground water quality criteria" to correct the citation to the definition of "ground water quality criteria" in the Ground Water Quality Standards, and delete the phrase "human health-based," as that phrase is not contained in the definition of "ground water quality criteria" in the Ground Water Quality Standards. Similarly,

for consistency the Department proposes to define "Surface Water Quality Standards" as the term is defined at N.J.A.C. 7:9B.

A new definition for the term "interim remediation standard" is proposed to mean a remediation standard that is established pursuant to N.J.A.C. 7:26D-6. Further, the definition of "person responsible for conducting the remediation" is being amended to make it consistent with the definition in the Administrative Requirements for the Remediation of Contaminated Sites at N.J.A.C. 7:26C-1.3.

The Department proposes to amend "regional natural background level" to change the phrase "environment in the region" to "environment of the region." The natural background level of a particular contaminant is measured based on the amount that is present over an area, rather than at a specific point; therefore, "environment of the region" is more appropriate. In the definition of "remediation" or "remediate," the existing reference to N.J.A.C. 7:26E-1.8 is being amended to remove the word "rules" at the end of "the Technical Requirements for Site Remediation," as that word is redundant.

Because the Department is proposing new remediation standards for indoor air for the vapor intrusion exposure pathway and for soil and soil leachate for the migration to ground water exposure pathway, it is necessary to amend the definition of "remediation standards" at N.J.A.C. 7:26D-1.5 to include those media and exposure pathways. The existing definition of "remediation standards" includes both the numeric standard and the narrative standard. Not all contaminants have a narrative standard; consequently, the proposed amended definition refers to a narrative standard, but only as appropriate. The existing definition indicates that a

remediation standard is one that the Department establishes pursuant to the Brownfield Act and this chapter. The proposed amended definition removes the reference to the Brownfield Act. The Brownfield Act is one of the authorities for the chapter; therefore, reference to a standard established in accordance with the chapter includes a standard established under the Brownfield Act. The Department also proposes to change the defined term from "remediation standards" to "remediation standard," and to change plural terms in the definition to singular. Where possible, the Department prefers to use singular terms in its rules, rather than plural terms.

Amendments to the Remediation Standards

Ground water remediation standards, N.J.A.C. 7:26D-2

Ground water remediation standards are codified at N.J.A.C. 7:26D-2. The Department establishes remediation standards based upon a particular contaminant's impact on human health and safety, and on the environment. As stated at N.J.A.C. 7:26D-2.2(a), the ground water quality standards developed pursuant to N.J.A.C. 7:9C-1.7 are also the ground water remediation standards. Proposed amended N.J.A.C. 7:26D-2.2(a)4vi replaces the existing reference to contaminants in concentrations that pose a threat to human health with a reference to concentrations that are in excess of a remediation standard. "Remediation standard" is a defined term in the proposed amended rules, and is more specific than the undefined generic phrase "that pose a threat to human health."

Existing N.J.A.C. 7:26D-2.2(a)4vii provides a list of factors to be considered when selecting an appropriate ground water remedial action. N.J.A.C. 7:26D-2 contains ground water

remediation standards, not criteria for selecting a remedy to clean up ground water; therefore, the Department proposes to delete the subparagraph. Information concerning criteria for selecting a remedy for ground water contamination can be found in the Technical Requirements, N.J.A.C. 7:26E, Administrative Requirements for the Remediation of Contaminated Sites, N.J.A.C. 7:26C, and various Department technical guidance documents.

Existing N.J.A.C. 7:26D-2.2(b) states that the Department shall not approve an alternative ground water remediation standard that is based on a site-specific risk assessment. The basis for this statement is that the Ground Water Quality Standards, N.J.A.C. 7:9C, do not provide a mechanism for the development of alternative remediation standards that are based on site-specific factors. Proposed amended N.J.A.C. 7:26D-2.2 discusses ground water remediation standards, not alternative remediation standards; alternative remediation standards, if available for a medium, are discussed in proposed amended N.J.A.C. 7:26D-8. Accordingly, the Department is proposing to delete this subsection.

Surface water remediation standards, N.J.A.C. 7:26D-3

Surface water remediation standards are codified at N.J.A.C. 7:26D-3. Existing N.J.A.C. 7:26D-3.2(a)1 refers to the Surface Water Quality Standards at N.J.A.C. 7:9B-1.14(c) and (d), but should refer to the standards at N.J.A.C. 7:9B-1.14(c) through (h). In 2009, the Department added new N.J.A.C. 7:9B-1.14(c) and recodified then-existing (c) and (d) as (d) through (h), but the cross-reference at N.J.A.C. 7:26D-3.2(a)1 was not updated. (See 41 N.J.R. 1565(a), 41 N.J.R. 4735(a).) The proposed amendment to N.J.A.C. 7:26D-3.2 updates the cross-reference to reflect

those changes to the Surface Water Quality Standards. Existing N.J.A.C. 7:26D-3.2(a)2ii refers generally to the narrative standards at N.J.A.C. 7:9B-1.14. The Department is proposing to amend this provision to refer specifically to the subsections within N.J.A.C. 7:26D-1.14 where the narrative criteria/standards are codified, making the existing reference to "narrative" unnecessary. However, "narrative" will remain at N.J.A.C. 7:26D-3.2(a)2 to indicate that the paragraph identifies narrative surface water remediation standards.

Existing N.J.A.C. 7:26D-3.2(a)2v provides a list of factors to be considered when selecting an appropriate surface water remedial action. N.J.A.C. 7:26D-3 contains surface water remediation standards, not criteria for selecting a remedy to clean up surface water; therefore, the Department proposes to delete this subparagraph. Information concerning criteria for selecting a remedy for surface water contamination can be found in the Technical Requirements, N.J.A.C. 7:26E, Administrative Requirements for the Remediation of Contaminated Sites, N.J.A.C. 7:26C, and various Department technical guidance documents.

Existing N.J.A.C. 7:26D-3.2(b) states that the Department shall not approve an alternative surface water remediation standard that is based on a site-specific risk assessment. The basis for this statement is that the Surface Water Quality Standards, N.J.A.C. 7:9B, do not provide a mechanism for the development of alternative remediation standards that are based on site-specific factors. Proposed amended N.J.A.C. 7:26D-3.2 discusses surface water remediation standards, not alternative remediation standards; the alternative remediation standards, if available for a medium, are discussed in proposed amended N.J.A.C. 7:26D-8. Accordingly, the Department is proposing to delete this subsection.

Soil and Soil Leachate Remediation Standards, N.J.A.C. 7:26D-4

Soil remediation standards are codified at existing N.J.A.C. 7:26D-4. The Department proposes to amend N.J.A.C. 7:26D-4.1, which describes the contents of Subchapter 4, to reflect that, as a result of proposed new rules discussed below, the subchapter will also include soil leachate remediation standards. The subchapter similarly would reflect the addition.

In the existing rules, the Department establishes a residential direct contact soil remediation standard for a given contaminant by determining the more stringent of either the ingestion-dermal human health-based criterion or the inhalation human health-based criterion for that contaminant. The more stringent health-based criterion is the remediation standard for that contaminant unless the practical quantitation level concentration is greater than the corresponding human health-based criterion. In that case, the practical quantitation level for the contaminant is the residential direct soil remediation standard. The Department uses this same approach for the existing nonresidential direct contact soil remediation standards. The proposed rules; however, establish separate residential and nonresidential soil remediation standards for the ingestion-dermal exposure pathway, and residential and nonresidential soil remediation standards for the inhalation exposure pathway.

In the existing rules, there are definitions for “residential use” and “non-residential use” at N.J.A.C. 7:26D-1.5. These definitions list the exposure assumptions that are used to derive a numerical remediation standard if a site is residential or non-residential, but these definitions do not define what is residential and what is non-residential. The Department is proposing

definitions for both "residential" and "nonresidential." As proposed, "residential" refers to properties used for residences, private and public schools as defined at N.J.S.A. 18A:1-1, charter schools established pursuant to N.J.S.A. 18A:36A-1 et seq., and childcare centers licensed pursuant to N.J.S.A. 30:5B-1 et seq. "Nonresidential" refers to properties used for commercial or industrial purposes.

Further, the Department is proposing to delete the definitions for "residential use" and "non-residential use." The existing definitions list several, but not all, of the exposure assumptions that are used to derive a numerical remediation standard if a site is residential or non-residential. As all of the exposure assumptions are listed and described in N.J.A.C. 7:26D Appendices 2, 3, and 5, the existing incomplete definitions of "residential use" and "non-residential use" are not needed.

The Department is proposing these separate residential and nonresidential soil remediation standards for the ingestion-dermal exposure pathway and the inhalation exposure pathway to emphasize that both the ingestion-dermal exposure pathway and the inhalation exposure pathway must be evaluated when remediating a contaminated site. As discussed above, the term "direct contact" currently pertains to soil remediation standards based on a combined evaluation of the ingestion-dermal and inhalation exposure pathways. The term is not applicable to the separate ingestion-dermal and inhalation remediation standards of the proposed rules. Accordingly, the Department proposes to remove references to "direct contact soil remediation standards" and "direct contact" throughout the chapter. For the same reason, and also because the Department is proposing to no longer separate residential and

nonresidential exposure pathways, the Department proposes to delete the definitions of "non-residential direct contact soil remediation standard" and “residential direct contact soil remediation standard" from N.J.A.C. 7:26D-1.5, and also to delete the terms throughout the chapter.

Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway, N.J.A.C. 7:26D-4.2

Existing N.J.A.C. 7:26D-4.2 contains the standards for residential direct soil contact. As stated above, the Department is proposing to no longer separate residential and nonresidential exposure pathways, nor is it referring to “direct contact” soil remediation standards. Therefore, the Department proposes to repeal existing N.J.A.C. 7:26D-4.2. Proposed new N.J.A.C. 7:26D-4.2 establishes the soil remediation standards for the ingestion-dermal exposure pathway. The Department proposes to amend the definition of “ingestion-dermal exposure pathway” at N.J.A.C. 7:26D-1.5. The proposed definition refers to contact with contaminants through the incidental ingestion of soil, and through dermal contact with soil. While it remains true that the ingestion-dermal exposure pathway involves ingestion of contamination and absorption of contamination through the skin, the proposed definition recognizes that the contamination is in the soil.

The proposed rule refers to and incorporates by reference proposed new N.J.A.C. 7:26D Appendices 1, 2, 10, and 11, discussed further below. Proposed new N.J.A.C. 7:26D Appendix 1 provides remediation standards tables for various media and exposure pathways: Table 1 of N.J.A.C. 7:26D Appendix 1 provides residential soil remediation standards for the ingestion-dermal exposure pathway, and Table 2 provides the non-residential soil remediation standards

for the same exposure pathway. Proposed N.J.A.C. 7:26D Appendix 2 provides the procedures and equations that the Department used to develop the ingestion-dermal soil remediation standard. Proposed N.J.A.C. 7:26D Appendices 10 and 11 contain the chemical and physical properties of contaminants, such as water solubility and water and air diffusivity, as well as the toxicity factors for the contaminants.

At N.J.A.C. 7:26D-4.2, the proposed soil remediation standard for a contaminant for the ingestion-dermal exposure pathway is based upon the more stringent value of the carcinogenic or noncarcinogenic ingestion-dermal human health-based criterion set forth in the applicable appendix, or the reporting limit, if the reporting limit is greater than the health-based criterion. At N.J.A.C. 7:26D-1.5, the Department proposes to define "reporting limit" by reference to its definition in the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-1.8. "Reporting limit" replaces "practical quantitation level (PQL)" throughout the rules, because a practical quantitation level contains a level of subjectivity, while the reporting limit does not.

Soil Remediation Standards for the Inhalation Exposure Pathway, N.J.A.C. 7:26D-4.3

Existing N.J.A.C. 7:26D-4.3 contains the standards for non-residential direct soil contact. As stated above, the Department is proposing to no longer separate residential and nonresidential exposure pathways, nor is it referring to "direct contact" soil remediation standards. Therefore, the Department proposes to repeal existing N.J.A.C. 7:26D-4.3. Proposed new N.J.A.C. 7:26D-4.3 establishes the residential and nonresidential soil remediation standards for the inhalation exposure pathway. The proposed new section follows the same format as

proposed new N.J.A.C. 7:26D-4.2, Soil remediation standards for the ingestion-dermal exposure pathway and refers to the relevant new appendices and tables.

The proposed new rule refers to and incorporates by reference proposed new N.J.A.C. 7:26D Appendix 1, which provides remediation standards tables for various media and exposure pathways: Table 3 provides residential soil remediation standards for the inhalation exposure pathway, while Table 4 provides the non-residential soil remediation standards for the same exposure pathway. Proposed N.J.A.C. 7:26D Appendix 3 lays out the procedures and equations that the Department used to develop the soil remediation standards for the inhalation exposure pathway. Proposed N.J.A.C. 7:26D Appendices 10 and 11, are also incorporated by reference.

The Department proposes to amend the definition of "inhalation exposure pathway" at N.J.A.C. 7:26D-1.5. The existing definition refers to human contact with contaminants through the inhalation of contamination. The proposed definition refers instead to human contact with contaminants through the inhalation of particles or vapors (or both) emanating from contaminated soil. As with the proposed amended definition of "ingestion-dermal pathway," discussed above, the proposed amended definition of "inhalation exposure pathway" recognizes that the contaminants are in the particulates and vapors that emanate from contaminated soil. The vapor intrusion exposure pathway also relates to contamination from vapors; however, the source of the vapors is from the migration of volatile contaminants from the subsurface into building interiors. To highlight the difference between the two exposure pathways, the proposed definition of "vapor intrusion exposure pathway" specifies that this exposure pathway is distinct from the inhalation exposure pathway.

At N.J.A.C. 7:26D-4.3, the proposed soil remediation standard for a contaminant for the inhalation exposure pathway is based upon the more stringent value of the carcinogenic or noncarcinogenic inhalation human health-based criterion set forth in the applicable appendix, or the reporting limit, if the reporting limit is greater than the health-based criterion.

Soil and Soil Leachate Remediation Standards for the Migration to Ground Water Exposure Pathway, N.J.A.C. 7:26D-4.4

N.J.A.C. 7:26D-4.4 codifies the proposed soil and soil leachate remediation standards for the migration to ground water exposure pathway. The Brownfield Act at N.J.S.A. 58:10B-12.c(1) states, "[f]or contaminants that are mobile and transportable to groundwater or surface water, the residential and nonresidential soil remediation standards shall be protective of groundwater and surface water." Consistent with this directive, the Department is proposing new soil and soil leachate remediation standards that address migration of contaminants to ground water. The existing rules do not establish soil and soil leachate remediation standards for the migration to ground water exposure pathway. Instead, the existing standards, known as impact to ground water standards, are developed on a site-by-site basis, based upon the Brownfield Act, N.J.S.A. 58:10B-1 et seq., and established Department guidance. See existing N.J.A.C. 7:26D-1.1(b), proposed to be deleted. In light of the proposed new section, the existing definition of "impact to ground water remediation standard" at N.J.A.C. 7:26D-1.5 is no longer necessary and is proposed for deletion.

"Migration to ground water exposure pathway," a new term at N.J.A.C. 7:26D-1.5, involves the migration of contaminants in the vadose zone (the unsaturated soil zone) to ground water and subsequent human exposure through the ingestion of ground water. The proposed soil and soil leachate remediation standards are designed to limit the amount of a contaminant that migrates from the vadose zone to ground water, such that the resulting ground water concentration will not exceed the applicable ground water remediation standard. Proposed new N.J.A.C. 7:26D-4.4, Soil and soil leachate remediation standards for the migration to ground water exposure pathway, is consistent with proposed new N.J.A.C. 7:26D-4.2 and 4.3, in that it refers to the relevant appendices, specifically N.J.A.C. 7:26D Appendices 1, 4, and 10.

Proposed new N.J.A.C. 7:26D Appendix 1, which provides remediation standards tables for various media and exposure pathways: Table 5 of N.J.A.C. 7:26D Appendix 1, which provides soil remediation standards for the migration to ground water exposure pathway, while Table 6 delineates the soil leachate remediation standards for the same exposure pathway. Proposed new N.J.A.C. 7:26D Appendix 4 provides the procedures and equations that the Department used to develop these remediation standards. Proposed new N.J.A.C. 7:26D Appendix 10, which lists relevant chemical properties, is also incorporated by reference.

In some cases, the value of the migration to ground water soil criterion for a contaminant is less than the reporting limit for the contaminant. Where that occurs, the proposed soil remediation standard for a contaminant is based upon the value of the migration to ground water soil criterion (as identified in the relevant appendix), or the reporting limit, whichever is greater (that is, the criterion will be required unless it is less than the reporting limit, in which

case the reporting limit would be utilized). However, for the soil leachate remediation standard, the proposed standard (as identified in the relevant appendix) is always greater than the reporting limit as it is based on the Ground Water Quality Standard, which incorporates the reporting limit if the health-based criterion is less than the reporting limit.

Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway, N.J.A.C. 7:26D-5

Proposed new N.J.A.C. 7:26D-5 contains indoor air remediation standards for the vapor intrusion exposure pathway. These standards apply to both residential and nonresidential sites. "Vapor intrusion exposure pathway" is a new term defined at N.J.A.C. 7:26D-1.5 as an exposure pathway involving human contact with contaminants through the inhalation of contaminated indoor air due to the migration of volatile contaminants from the subsurface into buildings. The vapor intrusion exposure pathway is distinct from the inhalation exposure pathway, as the inhalation exposure pathway addresses both volatile and particulate contamination in ambient air.

The contaminants to which the proposed indoor air remediation standards would apply are volatile hazardous substances found in ground water that result from a discharge and that have the potential to volatilize from the ground water, migrate through soil as part of soil gas, and infiltrate buildings through a process known as vapor intrusion. Levels of volatile hazardous substances in indoor air resulting from vapor intrusion could pose a human health risk.

The proposed new rule refers to and incorporates by reference proposed new N.J.A.C. 7:26D Appendix 1, Tables 7 and 8, which provides remediation standards tables for various media and exposure pathways. Table 7 of N.J.A.C. 7:26D Appendix 1 provides residential indoor

air remediation standards for the vapor intrusion exposure pathway, and Table 8 provides the nonresidential indoor air remediation standards for the same exposure pathway. Proposed new N.J.A.C. 7:26D Appendix 5 provides the procedures and equations that the Department used to develop these remediation standards.

At proposed new N.J.A.C. 7:26D-5.2, the indoor air remediation standard for a contaminant for the vapor intrusion exposure pathway is based upon the more stringent value of the carcinogenic or noncarcinogenic indoor air human health-based criterion set forth in the applicable appendix, or the reporting limit, if the reporting limit is greater than the health-based criterion.

Interim Remediation Standards, N.J.A.C. 7:26D-6

Existing N.J.A.C. 7:26D-5 provides procedures that the Department uses to establish interim soil remediation standards. Due to the addition of proposed new N.J.A.C. 7:26D-5, discussed above, the Department proposes to recodify N.J.A.C. 7:26D-5 and 6 as 6 and 7, respectively, with amendments. Because the Department is adding interim remediation standards for ground water and indoor air, it also proposes to amend recodified N.J.A.C. 7:26D-6.1, Purpose, to eliminate "soil" since the subchapter would no longer be limited to interim soil remediation standards. It would instead refer to "interim remediation standards" (or similar language), rather than "interim soil remediation standards" (or similar language) throughout the subchapter.

The amendments propose to expand the Department's ability to develop an interim remediation standard for a contaminant to include soil leachate and indoor air provided the contaminant in question is not listed in N.J.A.C. 7:26D Appendix 1. Further, the rulemaking would allow the Department to establish an interim remediation standard for ground water if the contaminant in question is not listed in the Ground Water Quality Standards, N.J.A.C. 7:9C Appendix, Table 1.

The proposed amended rule allows the Department to establish an interim remediation standard for a contaminant for the specified media and exposure pathways. Proposed amended N.J.A.C. 7:26D-6.2 describes the required procedures for developing an interim remediation standard as either those in the Ground Water Quality Standards, or in the proposed new appendices to N.J.A.C. 7:26D. The Ground Water Quality Standards at N.J.A.C. 7:9C-1.7(c) allow the Department to establish interim ground water quality criteria. An interim ground water quality standard for a contaminant is the greater of the interim ground water quality criterion and the practical quantitation level (PQL).

The Surface Water Quality Standards, N.J.A.C. 7:9B, do not provide a mechanism for establishing interim standards; therefore, the proposed rules do not provide for an interim surface water quality standard. As provided in the existing rule, the proposed amended rule also allows the person responsible for conducting the remediation to request that the Department develop an interim remediation standard; only Department-developed interim remediation standards may be used.

Updating Remediation Standards, N.J.A.C. 7:26D-7

The existing rules at N.J.A.C. 7:26D-6 (recodified as N.J.A.C. 7:26D-7) allow the Department to update a soil remediation standard without promulgating a rule pursuant to the Administrative Procedure Act, N.J.S.A. 52:14B-1 et seq., when the USEPA revises the data on which the remediation standard is based. Proposed amended N.J.A.C. 7:26D-7 provides a mechanism for the Department to update remediation standards for each of the media in the proposed amended chapter, except surface water because the existing Surface Water Quality Standards, N.J.A.C. 7:9B, do not provide a mechanism for the Department to update the standards for surface water. The Department proposes to define "updated remediation standard" at N.J.A.C. 7:26D-1.5 as a remediation standard that is established pursuant to N.J.A.C. 7:26D-7.

Proposed amended N.J.A.C. 7:26D-7.2 provides a procedure for the Department to update a remediation standard for a contaminant listed in proposed new N.J.A.C. 7:26D Appendix 1, Tables 1 through 8, as reflected in the proposed amended heading to the section. The Department would update the remediation standard for soil and indoor air if the USEPA revises toxicity information contained in the Integrated Risk Information System (IRIS) (as in the existing rule), or if the Department promulgates a new or revised maximum contaminant level (MCL) for a drinking water constituent or a ground water quality standard based on new or revised toxicity information developed by the New Jersey Drinking Water Quality Institute. The Department would also update a soil remediation standard for lead if the USEPA revises or replaces its Integrated Environmental Uptake Biokinetic (IEUBK) Model and Adult Lead Model

(ALM) and input parameters for lead. The proposed rule allows the Department to update a soil remediation standard and a soil leachate remediation standard for the migration to ground water exposure pathway when the Department updates a ground water quality criterion pursuant to the Ground Water Quality Standards at N.J.A.C. 7:9C-1.7(c)5.

When the Department updates a remediation standard, it will publish a notice of administrative change in the New Jersey Register and on its website (https://www.nj.gov/dep/rules/adminchg.html). This is the same procedure as in the existing rule. The existing rule does not state the effective date of the updated standard; however, under the Office of Administrative Law's Rules for Agency Rulemaking at N.J.A.C. 1:30-2.7(a), Administrative corrections and changes, a notice of administrative change is effective on the date it is filed with the Office of Administrative Law. This effective date is recited in the proposed rule. The proposed rule, like the existing rule, states that the notice of administrative change will identify the contaminant, the basis for the change, and the revised criterion to be listed in the appendix. The notice will also identify the relevant media and the exposure pathway. The existing rule applies only to soil remediation standards; therefore, the existing rule does not require the notice to identify the medium and exposure pathway to which the updated remediation standard applies.

When the Department updates a remediation standard, that new standard applies to all sites. However, the person responsible for conducting the remediation may continue to use a remediation standard in effect prior to the update of that standard, provided the conditions at proposed new N.J.A.C. 7:26D-7.2(e) are met. The person responsible for conducting the

remediation may continue to use a remediation standard, which is specified in a remedial action workplan or remedial action report for a site, provided that: (1) the remedial action workplan or remedial action report is submitted no later than six months after the effective date of the updated standard; (2) the remedial action workplan or remedial action report is approved by the Department or is certified by a licensed site remediation professional; (3) the remediation standard specified in the remedial action workplan or remedial action report for a given contaminant is not greater than an order of magnitude than the updated remediation standard; and (4) the remedial action shall comply with the applicable regulatory timeframes pursuant to the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-5.

Alternative Remediation Standards, N.J.A.C. 7:26D-8

The Brownfield Act, at N.J.S.A. 58:10B-12(f)1, provides that a person responsible for conducting the remediation may submit an application to the Department for the development of an alternative remediation standard. In lieu of using a remediation standard promulgated pursuant to N.J.A.C. 7:26D-4 and 5 (soil, soil leachate, and indoor air), a person responsible for conducting the remediation may submit a request to use an alternative remediation standard based on site-specific conditions, as outlined in proposed N.J.A.C. 7:26D-8, Alternative Remediation Standards. An alternative remediation standard, as defined at N.J.A.C. 7:26D-1.5, is a remediation standard that is established using site-specific factors. The existing definition of "alternative remediation standard" refers only to soil for residential and nonresidential uses. The proposed definition would expand to other media besides soil and would recognize the

existence of other kinds of uses, such as recreational or limited access, by not restricting the definition to residential and nonresidential uses.

Existing N.J.A.C. 7:26D-7 (recodified as N.J.A.C. 7:26D-8) is limited to the development of alternative remediation standards for only direct contact soil remediation standards. In contrast to existing N.J.A.C. 7:26D-7.1, which is limited to soil remediation, proposed amended N.J.A.C. 7:26D-8.1, Purpose, allows for the development of soil alternative remediation standards for the ingestion-dermal, inhalation, and migration to ground water exposure pathways, as well as indoor air alternative remediation standards for the vapor intrusion exposure pathway. The proposed rules do not provide a process for developing alternative remediation standards for surface water or ground water because the Surface Water Quality Standards, N.J.A.C. 7:9B, and the Ground Water Quality Standards, N.J.A.C. 7:9C, do not provide a mechanism for the development of alternative remediation standards that are based on site-specific factors.

Proposed amended N.J.A.C. 7:26D-8.2, Applicability, expands the applicability of alternative remediation standards to include standards for the migration to ground water and vapor intrusion exposure pathways because the Department is proposing new standards for both of these pathways. See proposed N.J.A.C. 7:26D-4 and 5, as discussed above. In addition, this section continues to allow for application of alternative remediation standards to sites, as well as expanding the application to areas of concern. An “area of concern” is a distinct location or environmental medium, as defined in the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-1.8. This wider application allows for alternative remediation standards to apply

to remediations of areas of concern, as site-specific factors may vary among multiple areas of concern at a site.

The Department proposes to repeal existing N.J.A.C. 7:26D-7.3, Basis for an alternative soil remediation standard, and replace it with proposed new N.J.A.C. 7:26D-8.3, Development of an alternative remediation standard. The existing section addresses alternative soil remediation standards only for direct contact pathways (ingestion-dermal and inhalation exposure pathways under the proposed rules), while the proposed new section also allows for the development of alternative remediation standards for the migration to ground water and vapor intrusion exposure pathways. See proposed N.J.A.C. 7:26D-4 and 5, discussed above.

The Brownfield Act, at N.J.S.A. 58:10B-12.f(2), authorizes the Department to require the use of an alternative remediation standard when it determines, based on the weight of the scientific evidence, that the use of the promulgated remediation standard would not be protective, or would be unnecessarily overprotective, of public health or safety, or of the environment, as appropriate. Proposed N.J.A.C. 7:26D-8.3(b) refers to the relevant provision of the Brownfield Act.

The Department has determined that its approval is necessary before some alternative remediation standards are implemented at a site or area of concern, but not for others. N.J.A.C. 7:26D Appendices 6 through 9 (discussed below) state whether prior Department approval is required. For example, N.J.A.C. 7:26D Appendix 6, section II, identifies an alternative remediation standard for soil for the ingestion-dermal exposure pathway as one that must be approved by the Department before it is implemented. Proposed N.J.A.C. 7:26D-8.3(c) and (d)

direct the person responsible for conducting the remediation to the applicable section of the rules: N.J.A.C. 7:26D-8.4, if the Department's prior approval is required, and N.J.A.C. 7:26D-8.5 if prior approval is not required. Whether or not prior Department approval is required, all alternative remediation standards are subject to the Department inspection and review process, as described in the Site Remediation Reform Act at N.J.S.A. 58:10C-21a. See proposed N.J.A.C. 7:26D-8.3(e).

As noted in the Brownfield Act, at N.J.S.A. 58:10B-12.f(1), Department approval of an alternative remediation standard is necessary to ensure that the standard satisfies the Department's rules, is protective of public health and safety, and is protective of the environment. Proposed amended N.J.A.C. 7:26D-8.4 codifies the Department's approval process for an alternative remediation standard. See N.J.A.C. 7:26D-8.4(a). The burden to demonstrate that the requested alternative remediation standard is protective rests with the person requesting the alternative remediation standard. The person is required to submit documentation, as described at N.J.A.C. 7:26D Appendices 6 through 9, incorporated by reference, for the Department to determine whether the person meets that burden. See N.J.A.C. 7:26D-8.4(b). The administrative process for the Department's approval of an alternative remediation standard is included at proposed N.J.A.C. 7:26D-8.4(c). As directed at N.J.A.C. 7:26D-8.4(d), the person responsible for conducting the remediation must also correct any deficiency in the documentation provided to the Department before using the proposed alternative remediation standard.

The Department has determined that in limited situations the development of an alternative remediation standard is straightforward and does not warrant prior Department approval pursuant to N.J.A.C. 7:26D-8.4. N.J.A.C. 7:26D-8.5 explains the process for the development of alternative remediation standards that do not require prior approval by the Department. Pursuant to proposed N.J.A.C. 7:26D-8.5, the person responsible for conducting the remediation must collect the information indicated for each applicable exposure pathway, as described in proposed new N.J.A.C. 7:26D Appendices 6 through 9 and incorporated by reference, and submit that information to the Department with the applicable remedial phase report or workplan pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E.

New N.J.A.C. 7:26D Appendices 1 through 12

The Department proposes to repeal existing N.J.A.C. 7:26D Appendices 1 through 6 and replace them with N.J.A.C. 7:26D Appendices 1 through 12. Proposed new N.J.A.C. 7:26D Appendix 1 contains tables of remediation standards for the various media and exposure pathways. Proposed new N.J.A.C. 7:26D Appendices 2 through 5 provide the procedures and equations that the Department used to develop the proposed remediation standards in N.J.A.C. 7:26D Appendix 1. Proposed new N.J.A.C. 7:26D Appendices 6 through 9 provide the methodology that the Department will use to develop alternative remediation standards. Proposed N.J.A.C. 7:26D Appendices 10 and 11 contain the chemical and physical properties of contaminants, and the toxicity factors for the contaminants. Proposed new N.J.A.C. 7:26D Appendix 12 demonstrates the equivalency between the equations used to develop the

proposed soil and indoor air remediation standards and the equations the USEPA used in its Regional Screening Levels when it developed soil and indoor air risk-based screening levels.

N.J.A.C. 7:26D Appendix 1

Existing N.J.A.C. 7:26D Appendix 1, lists 135 contaminants and associated soil remediation standards. To determine if it should identify additional contaminants and develop corresponding soil remediation standards, the Department reviewed and compared various contaminant or constituent lists, including the USEPA Contract Laboratory Program Target Analyte List/Target Compound List, the USEPA Priority Pollutant List, and the USEPA Regional Screening Levels. The Department also reviewed existing N.J.A.C. 7:26D Appendix 1, to determine if the soil remediation standard for each contaminant in the appendix should be maintained and whether the soil remediation standard is scientifically supported.

For two reasons the Department identified the USEPA Contract Laboratory Program Target Compound List of organic compounds and Target Analyte List of inorganic compounds and metals as the primary lists for the development of the proposed new soil remediation standards. First, the Technical Requirements for Site Remediation, N.J.A.C. 7:26E, require the analysis of samples for Target Compound List and Target Analyte List chemicals whenever contaminants are unknown or not well documented at a site. See N.J.A.C. 7:26E-2.1(c)1. Second, the two lists of chemicals are the primary lists that the USEPA Superfund Program uses in evaluating soil contamination at Superfund sites.

As a result of its review, the Department proposes new N.J.A.C. 7:26D Appendix 1, Table 1: Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway – Residential (mg/kg); Table 2: Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway – Nonresidential (mg/kg); Table 3: Soil Remediation Standards for the Inhalation Exposure Pathway – Residential (mg/kg); and Table 4: Soil Remediation Standards for the Inhalation Exposure Pathway – Nonresidential (mg/kg). Except as specifically identified below, the contaminants in the proposed tables are the same as those in existing N.J.A.C. 7:26D Appendix 1. The Department is establishing, at proposed new N.J.A.C. 7:26D Appendix 1, Tables 1 through 4, the soil remediation standards for 12 USEPA Target Compound List chemicals that do not have existing soil remediation standards: bis(2-chloroethoxy) methane, 4-chloroaniline, 2-chloronaphthalene, cyclohexane, 1,4-dioxane, 2-hexanone, isopropylbenzene, 4-methyl-2-pentanone, 4-nitroaniline, 1,2,4,5-tetrachlorobenzene, 2,3,4,6-tetrachlorophenol, and 1,1,2-trichloro-1, 2,2-trifluoroethane. Analytical results for these compounds are regularly reported by laboratories, as evidenced by detectable amounts of the compounds, when laboratories conduct Target Compound List chemical analyses, pursuant to the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-2.1(c)1. In addition, toxicity information exists for these compounds, and they have been detected at contaminated sites in New Jersey.

The Department is also proposing soil remediation standards at new N.J.A.C. 7:26D Appendix 1, Tables 1 through 4 for the following contaminants that do not have existing soil remediation standards: n-hexane (a contaminant commonly found at sites with vapor intrusion impacts), extractable petroleum hydrocarbons (a contaminant found at many sites), 1,2,4-

trimethylbenzene (a contaminant commonly associated with gasoline discharges) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (a highly toxic contaminant found at several sites in New Jersey).

The Department is not proposing soil remediation standards for benzo(ghi)perylene, carbazole, 4,6-dinitro-2-methylphenol, endosulfan sulfate, 2-nitroaniline, and phenanthrene, which are in existing N.J.A.C. 7:26D Appendix 1, because these standards are based on toxicity information that the USEPA no longer supports. Thus, there is no acceptable toxicity information available to develop these soil remediation standards. Existing N.J.A.C. 7:26D Appendix 1 contains individual remediation standards for 2,4-dinitrotoluene and 2,6-dinitrotoluene. Proposed N.J.A.C. 7:26D Appendix 1 instead contains a single remediation standard for a 2,4- and 2,6-dinitrotoluene mixture because the individual contaminants are normally detected together in samples. Finally, the Department does not propose remediation standards for acrolein, acrylonitrile, benzidine, 1,2-diphenylhydrazine, and n-nitrosodimethylamine, which are included in existing N.J.A.C. 7:26D Appendix 1, because these contaminants are rarely found at contaminated sites in New Jersey. If, however, any of these contaminants is found at a site, the Department may develop interim remediation standards pursuant to N.J.A.C. 7:26D-6.

The Department proposes to establish soil and soil leachate remediation standards at proposed new N.J.A.C. 7:26D Appendix 1, Table 5: Soil Remediation Standards for the Migration to Ground Water Exposure Pathway (mg/kg) and Table 6: Soil Leachate Remediation Standards for the Migration to Ground Water Exposure Pathway (ug/L). Except as provided below, the Department proposes to use the list of contaminants contained in Table 1 of the Department's

guidance document, "Development of Impact To Ground Water Soil Remediation Standards Using The Soil-Water Partition Equation" (Version 2.0 – November 2013) (see https://www.nj.gov/dep/srp/guidance/rs/partition_equation.pdf), and Appendix B of the guidance document, "Development Of Site-Specific Impact To Ground Water Remediation Standards Using The Synthetic Precipitation Leaching Procedure" (Version 3.0 – November 2013) (see https://www.nj.gov/dep/srp/guidance/rs/splp_guidance.pdf) as the basis for the development of soil and soil leachate remediation standards.

The Department is also proposing soil and soil leachate remediation standards for the migration to ground water exposure pathway for seven additional contaminants. These contaminants include 4-chloroaniline, 1,4-dioxane, 2-hexanone, isopropylbenzene, and 2,3,4,6-tetrachlorophenol, which are included in the USEPA Target Compound List. Analytical results for these five contaminants are regularly reported by laboratories as part of the Target Compound List chemical analysis, pursuant to the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-2.1(c)1. In addition, toxicity information exists for these five compounds, and they have been detected at contaminated sites in New Jersey. The Department is also proposing soil and soil leachate remediation standards for the migration to ground water exposure pathway for n-hexane, a contaminant commonly found at sites with vapor intrusion impacts, and 2,3,7,8-tetrachlorodibenzo-p-dioxin, a highly toxic contaminant found at several sites in New Jersey.

The Department is not proposing soil and soil leachate remediation standards for the migration to ground water exposure pathway for several contaminants currently listed in the "Default Impact to Ground Water Soil Screening Levels for Contaminants (mg/kg)" and "Default

Leachate Criteria for Class II Ground Water (µg/L)." The Department is not proposing soil and soil leachate remediation standards for the migration to ground water exposure pathway for 4,6-dinitro-2-methyphenol and endosulfan sulfate because there is no acceptable toxicity information available for the Department to develop health-based remediation standards. In addition, the Department is not proposing soil and soil leachate remediation standards for the migration to ground water exposure pathway for acrolein, acrylonitrile, benzidine, 1,2-diphenylhydrazine, and n-nitrosodimethylamine, which are listed in existing N.J.A.C. 7:26D Appendix 1, because they are rarely found as contaminants of concern at sites in New Jersey. If, however, any of these contaminants are found at a site, the Department may develop interim remediation standards pursuant to N.J.A.C. 7:26D-6.

The Department used its "Generic Vapor Intrusion Screening Levels" (March 2013), (see https://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_tables.pdf), as the basis for the selection of contaminants for development of indoor air remediation standards for the vapor intrusion exposure pathway. Except as provided below, the Department proposes to establish indoor air remediation standards for the contaminants listed in the above-referenced document at N.J.A.C. 7:26D Appendix 1, Table 7: Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway - Residential (ug/m^3) and Table 8: Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway - Nonresidential (ug/m^3).

The Department is proposing indoor air remediation standards for two contaminants that are not on the existing "Generic Vapor Intrusion Screening Levels" list. These contaminants

are 1,4-dioxane (a USEPA Target Compound List compound) and 1,2,4-trimethylbenzene (a contaminant commonly associated with gasoline discharges, which occur frequently).

Additionally, the Department is not proposing indoor air remediation standards for the following seven contaminants that are on the existing "Generic Vapor Intrusion Screening Levels" list: bromodichloromethane, bromoform, dibromochloromethane, 1,1-dichloroethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, and 1,1,2-trichloroethane. The Department previously developed indoor air screening levels for these seven compounds using route-to-route extrapolation. As discussed in the "Route-to-route extrapolation of toxicity data in the development of remediation standards" section of the notice of proposal Summary below, this methodology is invalid for the development of indoor air remediation standards for these seven contaminants.

Comparison of Existing Soil Remediation Standards and Proposed Soil Remediation Standards

Existing soil remediation standards for the ingestion-dermal and soil inhalation exposure pathways were compared against proposed soil remediation standards for these two exposure pathways. As there are no existing soil and soil leachate standards for the migration to ground water exposure pathway and indoor air remediation standards for the vapor intrusion exposure pathway, no comparison to the proposed remediation standards for these exposure pathways can be made.

Soil Remediation Standards – Ingestion-Dermal Exposure Pathway – Residential Exposure Scenario

There are existing and proposed soil remediation standards for the ingestion-dermal exposure pathway, residential exposure scenario, for 117 contaminants. The proposed soil remediation standards for 22 contaminants are more stringent than the corresponding existing soil remediation standards. The proposed and existing soil remediation standards for 31 contaminants are the same. The proposed soil remediation standards for 64 contaminants are less stringent than the existing soil remediation standards for those contaminants.

Soil Remediation Standards – Ingestion-Dermal Exposure Pathway – Nonresidential Exposure Scenario

There are existing and proposed soil remediation standards for the ingestion-dermal exposure pathway, residential exposure scenario, for 113 contaminants. The proposed soil remediation standards for 13 contaminants are more stringent than the corresponding existing soil remediation standards. The proposed and existing soil remediation standards for three contaminants are the same. The proposed soil remediation standards for 90 contaminants are less stringent than the existing soil remediation standards for those contaminants.

Soil Remediation Standards – Soil Inhalation Exposure Pathway – Residential Exposure Scenario

There are existing and proposed soil remediation standards for the inhalation exposure pathway, residential exposure scenario, for 33 contaminants. The proposed soil remediation standards for 13 contaminants are more stringent than the corresponding existing soil remediation standards. The proposed and existing soil remediation standard for one contaminant is the same. The proposed soil remediation standards for 19 contaminants are less stringent than the existing soil remediation standards for those contaminants.

Soil Remediation Standards – Soil Inhalation Exposure Pathway – Nonresidential Exposure Scenario

There are existing and proposed soil remediation standards for the inhalation exposure pathway, residential exposure scenario, for 27 contaminants. The proposed soil remediation standard for one contaminant is more stringent than the corresponding existing soil remediation standard. The proposed soil remediation standards for 26 contaminants are less stringent than the existing soil remediation standards for those contaminants.

N.J.A.C. 7:26D Appendices 2 and 3

The Remediation Standards at existing N.J.A.C. 7:26D Appendix 2 describe the methodology for the development of ingestion-dermal soil remediation standards, and existing Appendix 3 describes the methodology for the development of inhalation soil remediation standards. As the Department is proposing changes in the methodology used to develop soil remediation standards, the Department proposes to repeal and replace existing N.J.A.C. 7:26D Appendices 2 and 3. The Department is proposing new N.J.A.C. 7:26D Appendix 2 – Development of soil remediation standards for the ingestion-dermal exposure pathway, and N.J.A.C. 7:26D Appendix 3 – Development of soil remediation standards for the inhalation exposure pathway. Proposed new N.J.A.C. 7:26D Appendices 2 and 3 describe the new methodologies the Department used to develop soil remediation standards for the ingestion-dermal and inhalation exposure pathways.

N.J.A.C. 7:26D Appendices 4 and 5

Existing N.J.A.C. 7:26D Appendices 4 and 5 describe the methodologies for the development of alternative ingestion-dermal soil remediation standards and alternative inhalation soil remediation standards, respectively. Because the Department is proposing changes in methodology in the development of those alternative remediation standards, it proposes to repeal existing N.J.A.C. 7:26D Appendices 4 and 5, and relocate those proposed methodologies within proposed new N.J.A.C. 7:26D Appendix 6 – Development of alternative remediation standards for soil for the ingestion-dermal exposure pathway, and proposed new N.J.A.C. 7:26D Appendix 7 – Development of alternative remediation standards for soil for the inhalation exposure pathway.

The Department is also proposing new soil and soil leachate remediation standards for the migration to ground water exposure pathway; accordingly, the Department proposes to repeal existing N.J.A.C. 7:26D Appendix 4 and replace it with new N.J.A.C. 7:26D Appendix 4 – Development of the soil and soil leachate remediation standards for the migration to ground water exposure pathway. Because the Department is also proposing new indoor air remediation standards, the Department proposes to replace existing N.J.A.C. 7:26D Appendix 5 with new N.J.A.C. 7:26D Appendix 5 – Development of indoor air remediation standards for the vapor intrusion exposure pathway. Proposed new N.J.A.C. 7:26D Appendices 4 and 5 describe the methodologies the Department used to develop the proposed soil and soil leachate remediation standards for the migration to ground water exposure pathway, and the methodology the

Department used to develop the proposed indoor air remediation standards for the vapor intrusion exposure pathway.

N.J.A.C. 7:26D Appendices 6, 7, 8, and 9

The existing rules describe the methodologies for the development of alternative ingestion-dermal soil remediation standards (existing N.J.A.C. 7:26D Appendix 4) and alternative inhalation soil remediation standards (existing N.J.A.C. 7:26D Appendix 5). As the Department is proposing changes in methodology in the development of alternative remediation standards, the Department is proposing to repeal existing N.J.A.C. 7:26D Appendices 4 and 5 and replace them with proposed new N.J.A.C. 7:26D Appendix 6 – Development of alternative remediation standards for soil for the ingestion-dermal exposure pathway, and N.J.A.C. 7:26D Appendix 7 – Development of alternative remediation standards for soil for the inhalation exposure pathway. Further, the Department is proposing soil remediation standards for the migration to ground water exposure pathway. As a result, the Department is proposing new N.J.A.C. 7:26D Appendix 8 – Development of alternative remediation standards for soil for the migration to ground water exposure pathway. As the Department is also proposing new indoor air remediation standards, the Department is proposing new N.J.A.C. 7:26D Appendix 9 – Development of alternative remediation standards for indoor air for the vapor intrusion exposure pathway. Proposed new N.J.A.C. 7:26D Appendices 8 and 9 describe the methodology that the Department will use to develop soil and soil leachate alternative remediation standards for the migration to ground water exposure pathway, and the methodology the Department will

use to develop indoor air alternative remediation standards for the vapor intrusion exposure pathway. See proposed N.J.A.C. 7:26D-8.3(a).

N.J.A.C. 7:26D Appendix 10

The Department is proposing new N.J.A.C. 7:26D Appendix 10 – Chemical and physical properties of contaminants. This new appendix lists the chemical and physical properties of contaminants that are used in the development of the proposed remediation standards. The Department is including this information at N.J.A.C. 7:26D for transparency purposes, so that the regulated community is aware of the chemical and physical properties the Department used to develop the proposed remediation standards.

N.J.A.C. 7:26D Appendix 11

The Department is proposing new N.J.A.C. 7:26D Appendix 11 – Toxicity factors used in the development of the remediation standards, which lists the toxicity factors the Department used in its development of the proposed remediation standards. The Department proposes to include this information at N.J.A.C. 7:26D for transparency purposes, so that the regulated community is aware of the toxicity factors the Department used in developing the proposed remediation standards. This appendix also identifies the source of the toxicity factor.

N.J.A.C. 7:26D Appendix 12

Equations 1, 2, 3, and 4 contained in proposed new N.J.A.C. 7:26D Appendix 2 – Development of soil remediation standards for the ingestion-dermal exposure pathway, Equations 1 and 2 in proposed N.J.A.C. 7:26D Appendix 3 – Development of soil remediation standards for the inhalation exposure pathway, and Equations 1 and 2 in proposed N.J.A.C. 7:26D Appendix 5 – Development of indoor air remediation standards for the vapor intrusion exposure pathway, are all derived from equations found in the USEPA document, Regional Screening Levels (RSLs) – Equations (November 2018). The Department is proposing new N.J.A.C. 7:26D Appendix 12 – Derivation of equation equivalency used for the development of soil and indoor air remediation standards, which demonstrates the equivalency between the equations listed above that the Department used to develop the proposed soil and indoor air remediation standards, and the equations the USEPA used in the RSLs when it developed soil and indoor air risk-based screening levels.

Considerations for the Development of Proposed Remediation Standards

The Department reviewed the existing Remediation Standards, N.J.A.C. 7:26D, to determine whether the standards remain protective of public health and safety. The Department reviewed the toxicity factors, exposure assumptions, chemical factors, physical factors, and equations used to develop the existing soil remediation standards. The Department also reviewed the list of contaminants in the existing soil remediation standards. As a result of its review, the Department determined that some of the existing soil remediation standards could no longer be justified. It also determined that there was a need to develop soil

remediation standards for contaminants that are not in the existing rules. When it developed the proposed remediation standards, the Department considered toxicity information hierarchy, Group C carcinogens, regional natural background, soil saturation limit, vehicular traffic impact, route-to-route extrapolation of toxicity data, and reporting of numeric standards.

Hierarchy of Toxicity Source Information

The Department obtained the toxicity information used to generate remediation standards from a variety of sources; however, the Department relied on a hierarchy for the selection and use of this information. The first source of toxicity information the Department relied on was the toxicity information for contaminants identified in the New Jersey Safe Drinking Water Act at N.J.S.A. 58:12A-13. The Safe Drinking Water Act mandates that the Department establish maximum contaminant levels (MCLs) for a list of specific contaminants and provide for the establishment of maximum contaminant levels for additional contaminants based on occurrence and potential for human health effects. The Legislature established this list through amendments to the Safe Drinking Water Act (P.L. 1983, c. 443). The amendments are commonly referred to as "A-280" or "A-280 amendments." Thereafter, the Department adopted MCLs as drinking water quality standards, which are used as the basis for the existing New Jersey's Ground Water Quality Standards, N.J.A.C. 7:9C, and existing Surface Water Quality Standards, N.J.A.C. 7:9B. To maintain consistency with other State standards, the Department has used the A-280 contaminant toxicity information as the first source of toxicity information (first tier) for the development of soil ingestion-dermal absorption standards. Supporting documentation for A-280 toxicity information can be found in the New Jersey Drinking Water

Quality Institute's *Maximum Contaminant Level Recommendations for Hazardous Contaminants in Drinking Water, Appendix A, Health-Based Maximum Contaminant Level Support Documents and Addenda* (NJDWQI 1987 and 1994).

For those contaminants not addressed by the A-280 amendments, the Department used toxicity information from the USEPA Integrated Risk Information System (IRIS) database (second tier), which provides regularly updated, peer-reviewed toxicity information. For contaminants that do not have A-280 or IRIS toxicity values, the Department referred to its third preference of toxicity information (third tier), which was from a variety of sources, including, but not limited to: the USEPA National Center for Environmental Assessment (NCEA), which develops Provisional Peer-Reviewed Toxicity Values (PPRTV) that provide toxicity information; the USEPA Health Effects Assessment Summary Tables (HEAST); the California Environmental Protection Agency; and the Agency for Toxic Substances and Disease Registry. If toxicity information from multiple third tier sources existed, then the Department reviewed all available information and selected the most scientifically sound information in order to develop the proposed remediation standards.

In some instances, the Department developed toxicity factors from the primary scientific literature if toxicity information was not available from any of the above sources, or if a toxicity factor was warranted by new scientific information. In addition, for some contaminants, toxicity information from a lower tier source was used in lieu of toxicity information from a higher tier source if it was determined that the lower tier toxicity information was derived using better scientific information. The toxicology information that the Department used to develop the

proposed soil remediation standards for both the ingestion-dermal exposure pathway and the inhalation exposure pathway, and the toxicology information the Department used to develop the proposed indoor air remediation standards for the vapor intrusion exposure pathway are found in proposed N.J.A.C. 7:26D Appendix 11.

Group C Carcinogens

The Department has a policy for the development of remediation standards for Group C carcinogen contaminants, which are defined as possible human carcinogens by the USEPA (Group C carcinogens) (USEPA 1986. Guidelines for Carcinogen Risk Assessment. https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=54933&CFID=52936938&CFTOKEN=51704777). Group C carcinogen contaminants are contaminants for which some evidence of human carcinogenicity exists, but for which there is insufficient evidence to classify the contaminants as Known Human Carcinogens (Group A) or Probable Human Carcinogens (Group B). The Department uses this policy to develop Departmental health-based standards including remediation standards, drinking water health-based maximum contaminant levels, ground water quality criteria, and human health-based surface water quality criteria.

Under this Department policy, remediation standards for Group C carcinogen contaminants that have carcinogenic toxicity information are developed as a carcinogen (Group A or B) using a target cancer risk of one excess human cancer in one million people (1×10^{-6} target cancer risk). There are, however, some Group C carcinogen contaminants that do not have available carcinogenic toxicity information. For those contaminants, the Department

developed a remediation standard using non-carcinogenic toxicity information, but the Department applied an added uncertainty factor of 10 to account for potential carcinogenic effects.

The Department's Group C carcinogen policy affects 13 contaminants. These contaminants (and their related exposure pathway(s)) are set forth below.

Contaminant	Medium and exposure pathway
Atrazine	Soil ingestion-dermal
Butylbenzylphthalate	Soil ingestion-dermal
Dibromochloromethane	Soil ingestion-dermal
1,4-Dichlorobenzene	Soil ingestion-dermal
1,1-Dichloroethene	Soil ingestion-dermal, soil inhalation, and vapor intrusion
Beta HCH	Soil ingestion-dermal
Hexachloro-1,3-butadiene	Soil ingestion-dermal
Isophorone	Soil ingestion-dermal
2-Methylphenol	Soil ingestion-dermal
4-Methylphenol	Soil ingestion-dermal

Methyl tertiary butyl ether	Soil ingestion-dermal, soil inhalation, and vapor intrusion
Naphthalene	Soil ingestion-dermal, soil inhalation, and vapor intrusion
Tertiary butyl ether	Soil ingestion-dermal
1,1,2-Trichloroethane	Soil ingestion-dermal

The Department is aware that in 2005, the USEPA updated its *Guidelines for Carcinogen Risk Assessment* (USEPA, 2005. See https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment). The USEPA guidelines recommend using narrative descriptors for weight of evidence of carcinogenicity in place of the older alphabetic classification system. Contaminants that the USEPA and the Department formerly considered Group C carcinogens are now classified as contaminants with "Suggestive Evidence of Carcinogenic Potential." As a result, the Department has reviewed the updated guidelines and concurs that Group C carcinogens are equivalent to contaminants with "suggestive evidence of carcinogenic potential." Therefore, the Department determined that its policy concerning Group C carcinogens remains valid and applied the policy to establish the proposed remediation standards.

Regional Natural Background

In addition to requiring that soil remediation standards be health-based, the Brownfield Act, at N.J.S.A. 58:10B-12.g(4), precludes the Department from requiring the remediation of a

discharge to levels that are lower than regional natural background levels for any particular contaminant and not due to a single point discharge. When the Department first promulgated the Remediation Standards, N.J.A.C. 7:26D, the Department reviewed regional natural background levels of inorganic contaminants in soil in relation to the then-proposed health-based standards to ensure that the proposed soil remediation standards were not lower than frequently detected background levels in New Jersey (See 29 N.J.R. 1574(a), 40 N.J.R. 3187(a)). After an evaluation of a Statewide survey of background soil concentrations, the Department determined that arsenic is typically present in New Jersey soil at concentrations that were higher than the health-based criterion. Therefore, the Department proposed and adopted the existing soil remediation standard for arsenic based on background concentrations that are specific to New Jersey. The Department established a Statewide soil standard for arsenic of 19 mg/kg because the health-based criterion (0.5 mg/kg) was typically lower than the naturally occurring concentrations.

The Department based the Statewide background concentration for arsenic on a three-year study the Department conducted to determine background values of selected metals throughout the State. (See Sanders, P., 2002. Characterization of Ambient Levels of Selected Metals and Other Analytes in New Jersey Soils. This report is available at https://www.state.nj.us/dep/dsr/publications/pub.htm under the heading of "Environmental Health.") The Department collected a total of 248 soil samples in areas throughout the State not directly affected by local discharges. The Department included sampling in the piedmont, ridge

and valley, highlands, and coastal plain geographic provinces of the State. In addition, the Department collected samples in urban and rural areas within the sampled provinces.

The Department used the arsenic measured in these samples to represent the background arsenic concentrations in soil throughout the State, although some additional concentration of arsenic may have been present from diffuse anthropogenic sources. The Department used the sample data to develop the State's 95th percentile for arsenic contamination, which represents the concentration at which 95 percent of all the values in the data set are less than or equal to that concentration. The Department has determined that the data and analysis on which it based the 95th percentile remains valid and proposes to retain the soil remediation standard of 19 mg/kg for arsenic.

While the Department is proposing a Statewide soil remediation standard for arsenic, the Department recognizes that there is a wide variation in background concentrations of arsenic that exists across the State. Therefore, in those instances where the person responsible for conducting the remediation believes that the naturally occurring level of arsenic at a site is greater than 19 mg/kg, the person responsible for conducting the remediation can conduct a site-specific background determination as part of the remediation. The Department outlines the procedures to determine background levels of contaminants in soil on a site-specific basis in the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-3.8 and in the Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil, March 2015, Version 1.2 (https://www.nj.gov/dep/srp/guidance/srra/soil_inv_si_ri_ra.pdf).

Soil Saturation Limit

The soil saturation limit, or Csat value, corresponds to the contaminant concentration in soil at which the absorptive limit of the soil particles, the solubility limit of the soil pore water, and saturation of soil pore air are reached. For some contaminants, the Csat value is less than the calculated health-based soil criterion for the inhalation pathway. This means that, regardless of the concentration of the contaminant in soil, the contaminant's concentration in air cannot reach or exceed allowed health-based levels. For these contaminants, a health-based standard is irrelevant for the inhalation pathway. Accordingly, the Department did not establish numeric inhalation soil remediation standards for contaminants for which the calculated health-based criterion is greater than the contaminant's Csat value.

The Department used the soil-water partition equations at proposed N.J.A.C. 7:26D Appendix 4, to calculate a Migration to Ground Water Soil-Water Partitioning Criterion (MGWc) for each contaminant listed in N.J.A.C. 7:26D Appendix 1, Table 5 based on the numeric Ground Water Remediation Standard (GWRS), N.J.A.C. 7:26D-2.2(a)1, for each respective contaminant. The Department multiplied the GWRS by the default Dilution-Attenuation Factor of 20 to derive the Migration to Ground Water Soil Leachate Remediation Standard ($MGW_{LEACHATE}$).

For some contaminants, the calculated MGWc using the soil-water partition equation is greater than the contaminant's default soil saturation limit (Csat). Above the Csat concentration, formation of pure phase residual product occurs, either in liquid or particulate form. The Department considers this residual product to be immobile in the soil matrix, as long

as free product is not present, and it, therefore, does not pose a threat to ground water. Furthermore, at a concentration greater than Csat, a mobile contaminant dissolved in soil leachate remains at the mobile contaminant's water solubility concentration. When the calculated MGWc is greater than a contaminant's Csat limit, the contaminant concentration in the soil leachate is less than $MGW_{LEACHATE}$ because the leachate standard is greater than the contaminant's water solubility. Therefore, the Migration to Ground Water Pathway is irrelevant when this condition occurs, and remediation standards for the contaminants to which this pathway applies are not necessary.

The Department multiplied the GWRS by the default dilution-attenuation factor of 20 to derive the Migration to Ground Water Soil Leachate Remediation Standard ($MGW_{LEACHATE}$). $MGW_{LEACHATE}$ is the maximum allowed contaminant concentration in the soil leachate. Soil leachate consists of contaminants in mobile soil pore water that can drain down to the water table and contaminate the ground water, if the contaminant concentration is greater than $MGW_{LEACHATE}$.

Health-Based Criteria Greater than One Million Parts Per Million

There are instances when, in the calculation of a health-based criterion for a given contaminant, the calculated value results in a number that is greater than one million parts per million, which is not physically possible. Since one million parts per million of a contaminant corresponds to pure chemical (that is, the "soil" is completely the contaminant itself), this means that ingestion of pure chemical does not pose a human health risk, based on the exposure

assumptions in the calculation. Therefore, the Department has determined that development of a soil remediation standard for such a contaminant is not necessary.

Vehicular Traffic Impacts for the Inhalation Exposure Pathway

Vehicular traffic impacts for the inhalation exposure pathway refer to dust generated by vehicle movement. Although the Department included vehicular traffic impacts when it promulgated the existing rules in 2008, it did not take vehicular traffic impacts on the inhalation exposure pathway into account in developing the proposed remediation standards. Vehicular traffic impacts are not consistent with the conceptual approach used by the USEPA for the inhalation exposure pathway.

Route-to-Route Extrapolation of Toxicity Data in the Development of Remediation Standards

The Department restricted route-to-route extrapolation of toxicity data when it developed the proposed soil and indoor air remediation standards. Route-to-route extrapolation of toxicity data means the use of the toxicity data for one exposure pathway in the calculation of the remediation standard for another exposure pathway. Historically, the USEPA and the Department implemented route-to-route extrapolation when there was no toxicity information available for the exposure pathway under evaluation. However, subsequent USEPA Risk Assessment Guidance for Superfund: Part F, Supplemental Guidance for Inhalation Risk Assessment (Part F) recommends not using route-to-route extrapolation of ingestion toxicity data to develop inhalation exposure pathway standards, unless such toxicity data are

substantiated by additional evaluation (including physiologically-based pharmacokinetic modeling). Part F does allow for pharmacokinetic considerations.

Consequently, the Department did not use route-to-route extrapolation to develop remediation standards, unless there was a specific contaminant-based justification. As a result, because of the limited availability of inhalation exposure pathway-based toxicity data, the Department is not proposing inhalation exposure pathway remediation standards for 28 compounds that are in the existing rules. The 28 compounds are: aldrin, bis(2-chloroethyl)ether, bromodichloromethane, bromoform, 2-chlorophenol, DDD, DDE, DDT, dibromochloromethane, 3,3-dichlorobenzidine, 1,1-dichloroethane, cis-1,2-dichloroethene, dieldrin, alpha-HCH, beta-HCH, heptachlor, heptachlor epoxide, hexachlorobenzene, hexachloro-1,3-butadiene, lead, lindane, n-nitrosodi-n-propylamine, 2,2-oxybis(1-chloropropane), pentachlorophenol, polychlorinated biphenyls, tertiary butyl alcohol, 1,1,2,2-tetrachloroethane, and toxaphene.

The Department's restriction of route-to-route extrapolation also affects the Department's development of indoor air remediation standards for the vapor intrusion exposure pathway. The Department developed indoor air screening levels for seven compounds listed in the Department's "Generic Vapor Intrusion Screening Levels" using route-to-route extrapolation (see http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_tables.pdf). In the absence of route-to-route extrapolation, the Department is not proposing indoor air remediation standards for these seven compounds that are in the existing rules: bromodichloromethane, bromoform, dibromochloromethane, 1,1-dichloroethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, and 1,1,2-trichloroethane.

Reporting of Numeric Standards

The Department proposes remediation standards using the units set forth below.

Medium/Exposure Pathway	Unit
Ground water	Micrograms of contaminant per liter of water (µg/l), except as otherwise specified in the Ground Water Quality Standards, N.J.A.C. 7:9C
Surface water	Micrograms of contaminant per liter of water (µg/l), except as otherwise specified in the Surface Water Quality Standards, N.J.A.C. 7:9B
Soil: ingestion-dermal, inhalation, and migration to ground water	Milligrams of contaminant per kilogram of soil (mg/kg) on a dry weight basis
Soil leachate: migration to ground water	Micrograms of contaminant per liter of leachate (µg /l)
Indoor air	Micrograms of contaminant per cubic meter of air (µg /m^3)

The number of significant figures for the remediation standards varies, depending on the medium. For the ground water remediation standards, the Department proposes to express the

standard using one significant figure to be consistent with the Ground Water Quality Standards, N.J.A.C. 7:9C. The proposed surface water remediation standards are expressed using two significant figures to be consistent with the Surface Water Quality Standards, N.J.A.C. 7:9B. All other proposed remediation standards (soil ingestion-dermal, soil inhalation, soil and soil leachate migration to ground water, and indoor air) are expressed using two significant figures. The Department's approach is consistent with the USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (USEPA, Risk-Based Screening Table – Generic Tables https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables).

In deriving the proposed soil remediation standards for the ingestion-dermal and inhalation exposure pathways, soil and soil leachate remediation standards for the migration to ground water exposure pathway, and indoor air remediation standards for the vapor intrusion exposure pathway, the Department applied the rounding rules contained in American Society for Testing and Materials (ASTM) Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications (ASTM E29-13). For example, in applying ASTM E29-13:

- If the first number beyond the second significant figure is less than five, then the second significant figure remains the same, while the remaining numbers are dropped. For example, if 4.438 is rounded to two significant figures, the result is 4.4.
- If the first number beyond the second significant figure is greater than five, then the second significant figure increases by one and the remaining numbers are

dropped. For example, if 4.668 is rounded to two significant figures, the result is 4.7.

- If the first number beyond the second significant figure is five and there are other non-zero numbers beyond that five, then the second significant increases by one and the remaining numbers are dropped. For example, if 4.6534 is rounded to two significant figures, the result is 4.7.
- If the first number beyond the second significant figure is five, and there are no numbers beyond this five (except zeros), then the second significant figure is rounded to the closest even number. For example, if 4.55 is rounded to two significant figures, then the result is 4.6; and when 4.65 is rounded to two significant figures, the result is also 4.6.

Social Impact

The remediation of contaminated sites and the resulting protection of public health and safety and the environment have wide-ranging social benefits. The Remediation Standards are the Department's standards for remediating contamination at contaminated sites throughout the State. The proposed new rules, amendments, and repeals provide predictable, consistent, and flexible remediation goals to the person responsible for conducting the remediation and to the Department for the investigation and remediation of contaminated sites. The proposed rulemaking continues to ensure that the remediation of contaminated sites is protective of public health and safety and the environment.

Economic Impact

The Department anticipates that the proposed new rules, amendments, and repeals will have an economic impact on the persons responsible for conducting remediation of contaminated sites. The magnitude of the impact will vary, based on the site and the contaminants at issue.

Estimated Cost of Remediation

It is difficult to assign a specific dollar value for the cost of a typical remediation, due to the variety and complexity of contaminated sites throughout the State. Factors such as contaminants present, contaminant distribution, media impacted, and remedy selected all have significant influence on the cost to remediate a site. For purposes of this discussion, remediation costs are the costs to investigate and remediate the contamination present. The Department's estimates are based on three sources of information.

The first source is an internal Department database that includes estimates from private parties of the cost of remediating discharges from regulated underground tanks. The Department considers a discharge from an underground storage tank as only a single area of concern. The cost estimates in this internal database are associated with the remediation of areas of concern, rather than the remediation of an entire site. There are 2,285 locations in the database, and median remediation cost is $23,000 per location. The reported costs range from $340.00 to $14 million. The cost range is wide because the internal database includes sites that contain multiple underground storage tanks (such as gasoline and petroleum product storage

and distribution centers) that discharged large amounts of contaminants, which resulted in the remediation of large volumes of contaminated soil and ground water.

The second source of information is managers and site managers in the Department's Site Management group, which oversees Superfund sites and other high priority State sites. The cost estimates from the managers and site managers is site-wide, potentially including many areas of concern, and including all remedial phases (remedial investigation and remedial action), for both simple and complex sites. Note that because of the nature of the Department's contracting procedures (including prevailing wage requirements) and its publicly funded remedial approach of implementing unrestricted use remedial actions (as opposed to restricted or limited restricted remedial actions), the costs of remediation of these sites are likely greater than the costs associated with comparable privately conducted remediation. For simple sites (such as sites with less than 20 areas of concern or sites with only soil contamination), the remediation cost estimates range from $300,000 to $900,000. For complex sites (such as sites with 20 or more areas of concern or sites with both soil and ground water contamination), the remediation cost estimates range from $2,150,000 to $51 million. The median cost for remediation of a simple site is $800,000, while the median cost for remediation of a complex site is $2,850,000.

The Department's third source of information is the Remediation Funding Source database. This database contains remediation cost information for 1,267 sites. The cost estimates are those of the person responsible for conducting the remediation of the site and are based on site-wide costs. The median remediation cost estimate in this database is

approximately $147,000. Because of the varying complexity of the individual sites and remediations included in this database, the reported remediation costs range from $1,600 to $128 million.

Impact of More Stringent Remediation Standards

As discussed above in the Summary, for a number of contaminants the Department proposes remediation standards that are more stringent than the existing remediation standards. In some cases, the more stringent standards will result in additional remediation costs, although the Department is not able to estimate the magnitude of the increase in costs because the conditions at each site are unique.

An increase in costs will not result in all cases, however. For example, assume that contaminants A and B are comingled at a site. Also assume that the Department proposes a remediation standard for contaminant B that is more stringent than the existing standard. If contaminant A is driving the remediation at the site, and contaminant B is not, then the remediation of contaminant A will concurrently remediate contaminant B to a level that meets the proposed amended remediation standard for contaminant B. Therefore, the amended remediation standard for contaminant B will not materially affect the cost of the remediation. However, if contaminant B is more widely distributed than contaminant A on the site, then the amended remediation standard for contaminant B may affect the cost of the remediation. Remediation of contamination A will also remediate contaminant B in some parts of the site, but

the person responsible for the remediation will need to remediate contaminant B where it occurs elsewhere.

The reporting limit can lessen the impact of the proposed decrease in a remediation standard. The degree of remediation is determined by the larger of either the health-based calculated value or the reporting limit. If the existing health-based value for a contaminant is below the reporting limit for the contaminant, then the proposed further reduction in the remediation standard will not have an economic impact. Remediation to the reporting limit is all that is required.

Remediation below regional natural background levels is also not required; therefore, a decrease in a remediation standard for a contaminant, if the existing standard for a contaminant is already below background levels, will not result in additional costs of remediation. If the existing remediation standard for a contaminant is above background levels and the proposed new standard is below, then there might be an increase in the remediation cost; the remediation of the contaminant would need to meet the background level, but would not need to meet the proposed new standard.

Impact of Removal of a Remediation Standard

As discussed in the Summary above, the Department is proposing to delete remediation standards for some contaminants, such as acrolein, acrylonitrile, benzidine, 1,2-diphenylhydrazine, and n-nitrosodimethylamine. To the extent that an area of concern (or site) is contaminated with only one or more of these compounds, then the absence of a remediation

standard will reduce the cost of remediating the area of concern (or site). However, if one of the contaminants for which no remediation standard is proposed is comingled with another contaminant that must be remediated, then the lack of a remediation standard will have little impact on the cost of the remediation.

Proposed Soil Remediation Standards that Decrease by an Order of Magnitude or More

As provided in the Brownfield Act, at N.J.S.A. 58:10B-12.j, the Department cannot compel the use of a newly promulgated remediation standard at a site that has an approved remedial action workplan, unless the new remediation standard is more stringent than the remediation standard approved in the remedial action workplan or other plan by an order of magnitude or more. As also provided in the Brownfield Act, at N.J.S.A. 58:10B-13.e, the Department cannot compel the use of a newly promulgated remediation standard at a site that has been issued a final remediation document, unless the new remediation standard is more stringent than the remediation standard approved in the final remediation document by an order of magnitude or more, and the difference between the new remediation standard and the level or concentration of a contaminant at the site differs by an order of magnitude or more. Proposed remediation standards that are impacted by the order of magnitude provision in the Brownfield Act are listed in the Summary section "Amendments to the General Information, N.J.A.C. 7:26D-1," above.

The proposed soil remediation standard for ethylbenzene (soil inhalation exposure pathway) is more than an order of magnitude more stringent than the existing soil remediation standard for ethylbenzene (ingestion-dermal exposure pathway). Ethylbenzene is a gasoline

component and, as such, it is a common contaminant. The Department reviewed analytical data for ethylbenzene in the Department's COMPASS database to determine the potential economic impact of the proposed ethylbenzene soil remediation standards on the remediation of contaminated sites. The Department found that there are 15 active sites and three closed sites that have ethylbenzene contamination in soil in excess of the existing residential soil remediation standard. In addition, seven active sites and one closed site also have ethylbenzene in excess of the existing nonresidential soil remediation standard. Further, there were 1,717 additional active sites and 741 additional closed sites that have ethylbenzene in excess of the proposed residential soil remediation standard, while there are 1,172 additional active sites and 363 closed sites that have ethylbenzene contamination in excess of the proposed nonresidential soil remediation standard. Therefore, there is a potential for significant economic impact resulting from the need to reopen cases and implement additional remedial action. The factor easing any cost impact for such cases is that ethylbenzene is typically commingled with benzene, another gasoline component. Historically, benzene has driven the remediation (been the determinant of the extent of contamination to be remediated) when a gasoline discharge has occurred. The contaminants are usually comingled, and remediation of benzene will also remediate the ethylbenzene. Thus, even with the proposed change in the ethylbenzene standard, benzene may still determine the extent of the remediation required. Consequently, the actual economic impact will depend on the site-specific concentrations of each contaminant present.

The proposed soil remediation standards for benzaldehyde, butylbenzylphthalate, cobalt (ingestion-dermal exposure pathway), and caprolactum (soil inhalation exposure pathway) are more than an order of magnitude more stringent than the existing soil remediation standards for these contaminants. The Department reviewed analytical data for these contaminants in the Department's COMPASS database to determine the potential economic impact of the proposed remediation standards on the remediation of contaminated sites.

The Department found that there are no active or closed sites that have benzaldehyde contamination in soil in excess of the existing residential and nonresidential exposure scenario remediation standards. Additionally, there are no active or closed sites that have benzaldehyde contamination in soil in excess of the proposed residential and nonresidential exposure scenario remediation standards. Consequently, the Department does not anticipate any economic impact.

Similarly, there are no active or closed sites that have caprolactum contamination in soil in excess of the existing residential and nonresidential exposure scenario remediation standards. There are two active sites and no closed sites that have caprolactum contamination in soil in excess of the proposed residential and nonresidential exposure scenario remediation standards. Accordingly, the Department anticipates that there will be very minimal economic impact.

The Department notes that only the nonresidential soil remediation standard for butylbenzylphthalate is affected by the order of magnitude provision; there are no sites (active or closed) that have butylbenzylphthalate contamination in soil in excess of the existing nonresidential exposure scenario remediation standard. There are three active and two closed

sites that had butylbenzylphthalate contamination in soil in excess of the proposed nonresidential exposure scenario remediation standard. As a result, the Department expects very minimal economic impact.

As for cobalt, only the nonresidential soil remediation standard for cobalt is affected by the order of magnitude provision. The Department found that there are six active sites and one closed site that have cobalt contamination in soil in excess of the existing nonresidential exposure scenario remediation standard. Also, there are an additional 238 active sites and 90 closed sites that have cobalt contamination in soil in excess of the proposed nonresidential exposure scenario remediation standard. This represents an 18 percent increase (active sites) and a nine percent increase (closed sites) in the number of impacted sites that have any level of cobalt contamination in soil. The percentage would be much lower if one were to consider all of the Department's active sites (13,473 as of October 2019) and closed sites (approximately 68,000 as of October 2019). In sum, the Department anticipates a minimal economic impact.

The proposed soil remediation standard for hexachlorocyclopentadiene (migration to ground water exposure pathway) is more than an order of magnitude more stringent than the existing impact to ground water soil screening level. The Department reviewed analytical data for hexachlorocyclopentadiene in the Department's COMPASS database to determine the potential economic impact of the proposed remediation standard on the remediation of contaminated sites. The Department found that there are no active sites or closed sites that had hexachlorocyclopentadiene contamination in soil in excess of the existing impact to groundwater screening level. There are five active sites and one closed site that have

hexachlorocyclopentadiene contamination in soil in excess of the proposed migration to groundwater soil remediation standard. Consequently, the Department expects very minimal economic impact.

The proposed indoor air remediation standard for 1,1-dichloroethene (vapor intrusion exposure pathway) is more than an order of magnitude more stringent than the existing indoor air screening level for this contaminant. The Department reviewed analytical data for 1,1-dichloroethene in the Department's COMPASS database to determine the potential economic impact of the proposed remediation standard on the remediation of contaminated sites. There are 21 active sites and no closed sites that have 1,1-dichloroethene contamination in indoor air in excess of the existing residential indoor air screening level. There are eight active sites and no closed sites that had 1,1-dichloroethene contamination in indoor air in excess of the existing nonresidential indoor air screening level. The Department found that there are 26 additional active sites and three closed sites that have 1,1-dichloroethene contamination in indoor air in excess of the proposed residential indoor air remediation standard. There are 19 additional active sites and no additional closed sites that have 1,1-dichloroethene contamination in indoor air in excess of the proposed nonresidential indoor air remediation standard. Given the total number of the Department's active sites (13,473) and closed sites (approximately 68,000), the 45 additional active and three closed sites that would be affected constitute 0.059 percent of all sites. Therefore, the Department expects very minimal economic impact as a result of the proposed indoor air remediation standard for 1,1-dichloroethene (vapor intrusion exposure pathway).

Impact of Newly Regulated Exposure Pathways

As discussed in the Summary above, the Department proposes remediation standards for exposure pathways that are not in the existing rules, including soil and soil leachate remediation standards for the migration to ground water exposure pathway, and indoor air remediation standards for the vapor intrusion exposure pathway. While the Department does not have promulgated remediation standards for these exposure pathways, the Department has developed soil, soil leachate, and indoor air remediation standards on a site-specific basis pursuant to the Brownfield Act. The Brownfield Act, at N.J.S.A. 58:10B-12.a, states, "[u]ntil the minimum remediation standards for the protection of public health and safety as described herein are adopted, the department shall apply public health and safety remediation standards for contamination at a site on a case-by-case basis based upon the considerations and criteria enumerated in this section."

As the Department has developed, and continues to develop, remediation standards for contaminants for the migration to ground water and vapor intrusion exposure pathways on a site-specific basis, any additional economic impact on promulgating remediation standards for contaminants for these two exposure pathways is minimal.

Alternative Remediation Standards

An alternative remediation standard is a remediation standard that is established using site-specific factors. The person responsible for conducting a remediation may submit a request

to the Department to use an alternative remediation standard, as provided in proposed amended N.J.A.C. 7:26D-8, Alternative Remediation Standards. Although the Department expects an increase in the number of alternative remediation standard requests, the Department anticipates that it has sufficient staff to review such requests, such that remediations will not be delayed. The cost of Department review and approval of an alternative remediation standard is covered in the annual remediation fee assessed to the person responsible for conducting the remediation pursuant to the Administrative Requirements for the Remediation of Contaminated Sites at N.J.A.C. 7:26C-4.3.

The person responsible for conducting the remediation will require the services of a consultant to develop an alternative soil remediation standard. In most cases, this will be the licensed site remediation professional (LSRP) that is overseeing the remediation. The costs associated with the development of an alternative soil remediation standard may involve the collection of additional site-specific data, the calculation of a standard through the use of formulas or more complex computer modeling, the preparation of reports, and additional costs associated with the review of the reports. However, for some alternative remediation standards, most of the information may already be available as part of the remedial investigation. Consequently, the Department anticipates that the cost of obtaining an alternative remediation standard may vary widely.

An example of a simple alternative remediation standard option would be the development of an alternative remediation standard based on site-specific soil pH, which could cost about $200.00. The cost of measuring soil pH as part of the collection of samples and the

chemical analysis is about $25.00 per sample. A site-specific soil water partition coefficient is developed using the site-specific pH to generate an alternative remediation standard using the soil water partitioning equation.

Development of an alternative remediation standard using Vadose Zone and Ground Water Modeling (SESOIL/AT123D), is an example of a more complex and intensive approach to develop a site-specific alternative remediation standard for the migration to ground water pathway. However, pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E, in order to pursue this alternative remediation standard option, the person responsible for conducting the remediation is already required to collect much of the required information, such as the requirements to determine ground water flow velocity and direction, and the complete vertical and horizontal delineation of ground water contamination. There will, however, be some additional cost because the person responsible for conducting the remediation may also wish to collect and use data on additional site-specific parameters, such as soil texture and soil organic carbon content. Additional costs could range from $50.00 to $200.00 per sample for these additional analyses. The site-specific measurements are entered into the SESOIL model to generate the site-specific source input data for the AT123D model. In addition to owning a copy of the software (an estimated $1,000 cost), a person trained to run the SESOIL and AT123D models is needed. Additional costs will be incurred in the preparation of a report for submittal to the Department. However, the Department anticipates that the cost of developing an alternative remediation standard will be small, when compared to the cost of a remediation conducted using a default remediation standard as a remedial goal.

Environmental Impact

The proposed new rules, amendments, and repeals will have a positive environmental impact, insofar as they require remediation of contamination to more stringent standards and from more exposure pathways than the existing rules. As required by the Brownfield Act, the Department established the proposed remediation standards in order to protect human health and safety and the environment. Applying the proposed remediation standards to the remediation of contaminated sites will ensure that New Jersey's soils, surface water, and extensive ground water resources are protected from further contamination and are cleaned up to levels that are protective of human health and the environment. Protection of these resources is important to ensure high quality ground water for commercial, domestic, industrial, and environmental uses.

Federal Standards Analysis

N.J.S.A. 52:14B-1 et seq., require State agencies that adopt, readopt, or amend State rules that exceed any Federal standards or requirements to include in the rulemaking document a Federal standards analysis. The Department conducted this analysis for each of the remediation standards by environmental medium (soil, soil leachate, indoor air, ground water, and surface water) and exposure pathway (ingestion-dermal, inhalation, migration to ground water, and vapor intrusion), as discussed below.

Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway

Federal law does not require soil remediation standards for the ingestion-dermal exposure pathway, nor has the USEPA promulgated any. Rather, the USEPA has developed and maintained Regional Screening Levels, which are provided as guidance. The Department proposes soil remediation standards for the ingestion-dermal exposure pathway for 133 contaminants for the residential exposure scenario and 129 contaminants for the nonresidential exposure scenario. Comparison of the Department's proposed soil remediation standards for the ingestion-dermal soil exposure pathway and the USEPA Regional Screening Levels reveals that soil remediation standards for the ingestion-dermal exposure pathway of 24 contaminants are more stringent than the corresponding USEPA Regional Screening Level. The Department proposes more stringent standards for benzene, carbon tetrachloride, chlordane, chlorobenzene, 1,2-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethane, methylene chloride, and xylene. The proposed standards for these contaminants result from the application of the Department toxicological hierarchy that is discussed in the Summary above.

The more stringent proposed standards for aldrin, 4,4-DDE, endosulfan, heptachlor, heptachlor epoxide, hexachlorobenzene, hexachloro-1,3-butadiene, hexachlorocyclopentadiene, hexachloroethane, lindane, and 1,2,4,5-tetrachlorobenzene are based on the application of a skin absorption factor, because the Department considers these compounds to be semi-volatile organic compounds. The USEPA Regional Screening Levels do not apply a skin absorption factor to these compounds as they are considered volatile organic compounds by the USEPA. The

dermal absorption component of the ingestion-dermal pathway is derived from risk assessment methodology outlined in USEPA's *Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment)* Final (USEPA 2004). The USEPA evaluation of soil contaminants for dermal exposure are limited to several individual compounds, polycyclic aromatic hydrocarbons, and semi-volatile organic compounds. The USEPA has not developed default dermal absorption values for volatile organic compounds because they tend to volatilize from the soil adhered to skin, and exposure should be accounted for via the inhalation exposure pathway.

The proposed more stringent standards for 2-methylphenol and 4-methylphenol result from the Department's application of its Group C carcinogen policy, discussed in the Summary above. The Department proposes a standard for tertiary butyl alcohol, which does not have an USEPA Regional Screening Level.

Soil Remediation Standards for the Inhalation Exposure Pathway

The promulgation of soil remediation standards for the inhalation exposure pathway is not mandated by Federal law, nor has the USEPA promulgated soil remediation standards for it. Rather, as stated above, the USEPA has developed and maintained Regional Screening Levels, which are provided as guidance instead of standards. The Department proposes soil remediation standards for the inhalation exposure pathway for 40 contaminants for the residential exposure scenario and 30 contaminants for the nonresidential exposure scenario. Comparison of the Department's proposed soil remediation standards for the inhalation exposure pathway and the

USEPA Regional Screening Levels reveals that the soil remediation standards for the inhalation exposure pathway of three contaminants are more stringent than the corresponding USEPA Regional Screening Level.

The three contaminants with the more stringent remediation standards are 1,1-dichloroethene, caprolactum, and phenol. The proposed standard for 1,1-dichloroethene for the residential and nonresidential exposure scenarios are based on application of the Department Group C carcinogen policy which is discussed in the Summary above. The proposed standard for caprolactam for the inhalation exposure pathway is also more stringent for the residential and nonresidential exposure scenarios, as the Department treats this compound as a volatile while the USEPA does not. The Department proposes a more stringent standard for phenol for the inhalation exposure pathway for only the residential exposure scenario, as the Department treats this compound as a volatile and the USEPA does not. In the development of a health-based remediation standard for the soil inhalation exposure pathway, the Department evaluates the effect of the inhalation of contaminants adsorbed to fine soil particles and the inhalation of contaminants that volatilize from fine soil particles. The Department applies the volatilization factor to only those contaminants that are considered volatiles. Because of this, contaminants that are considered volatiles tend to pose a greater health risk compared to non-volatiles and have remediation standards that are more stringent.

Soil and Soil Leachate Remediation Standards for the Migration to Ground Water Exposure Pathway

Soil Remediation Standards

The promulgation of soil remediation standards for the migration to ground water exposure pathway using soil-water partitioning is not mandated by Federal law. The USEPA has not promulgated soil remediation standards for the migration to ground water exposure pathway using soil-water partitioning. Rather, the USEPA has developed and maintained Regional Screening Levels based on soil-water partitioning, which are provided as guidance instead of standards. The Department proposes soil remediation standards for the migration to ground water exposure pathway using soil-water partitioning for 106 contaminants. Comparison of the Department's proposed soil remediation standards for the migration to ground water exposure pathway using soil-water partitioning and the USEPA Regional Screening Levels reveals that the Department's remediation standards for eight contaminants are more stringent than the corresponding USEPA Regional Screening Level.

The proposed standards for 1,3-dichlorobenzene and tertiary butyl alcohol are more stringent because there is no USEPA Regional Screening Level. The proposed standard for beryllium is more stringent because the Department's ground water quality standard (from which the standard is derived) is lower than the Federal drinking water standard. Similarly, the proposed standards for 2-butanone, dibromochloromethane, n-hexane, 4-methylphenol, and silver are more stringent because the Department's ground water quality standard (from which the standard is derived) is more stringent than the USEPA-recommended tap water concentration.

Soil Leachate Remediation Standards

The promulgation of soil leachate remediation standards for the migration to ground water exposure pathway using the synthetic precipitation leaching procedure (SPLP) is not mandated by Federal law. The USEPA has not promulgated soil leachate remediation standards for the migration to ground water exposure pathway. The USEPA has no comparable Regional Screening Levels using SPLP.

Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway

The USEPA has not promulgated indoor air remediation standards but has developed and maintained Regional Screening Levels, which are provided as guidance instead of standards. The Department proposes indoor air remediation standards for 35 contaminants. Comparison of the Department-proposed indoor air remediation standards and the USEPA Regional Screening Levels reveals that the indoor air remediation standard of only one contaminant, 1,1-dichloroethene, is more stringent than the USEPA Regional Screening Level for both the residential and nonresidential exposure scenarios. This difference is based on the Department Group C carcinogen policy, which is discussed further in the Summary above.

Ground Water Remediation Standards

The ground water remediation standards are linked directly to New Jersey's Ground Water Quality Standards (GWQS). The GWQS provide the basis for protection of ambient ground water quality in New Jersey by establishing constituent standards for ground water

pollutants. These constituent standards apply to: (i) effluent limitations and discharge requirements pursuant to the New Jersey Pollutant Discharge Elimination System (NJPDES) permitting program (N.J.A.C. 7:14A); (ii) ground water remediation standards pursuant to the Brownfield and Contaminated Site Remediation Act, N.J.S.A. 58:10B-1 et seq.; and (iii) other requirements and regulatory actions applicable to discharges that cause or may cause pollutants to enter the ground waters of the State. The authority for setting these standards comes solely from New Jersey law and it has no Federal counterpart.

Surface Water Remediation Standards

The surface water remediation standards are linked directly to New Jersey's Surface Water Quality Standards (SWQS), N.J.A.C. 7:9B. The policies and standards in the SWQS are either exempt from Federal standards, or they are identical to or consistent with the Federal water quality standards. The surface water aquatic life and human health protection criteria (both narrative statements and numeric values) for New Jersey waters meet the Federal requirements as to the protection of designated uses of the waters, based on Federal Clean Water Act (CWA) guidance or guidance modified to reflect site-specific conditions, or other scientifically defensible methods.

Jobs Impact

The Department anticipates that the proposed new rules, amendments, and repeals will not have an impact on job retention and creation in the State. Although the proposed rules do

change the remediation standards for some contaminants, and provide standards based on exposure pathways that are not in the existing rules, the proposed rules do not change the underlying obligation of persons responsible for conducting the remediation to timely remediate contamination. The same personnel that are required for remediation under the existing rules will be needed to comply with the proposed rules.

Agricultural Industry Impact

In accordance with N.J.S.A. 4:1C-10.3, the Right to Farm Act, the Department has determined that the proposed new rules, amendments, and repeals, may impact agriculture in the State. A discharge at an agricultural establishment has the same potential to harm public health and safety and the environment as a discharge at any other type of site and, thus, must be remediated in accordance with all environmental statutes and rules. Accordingly, the proposed rules may have an impact on the agricultural community in New Jersey, to the extent that the owner of an agricultural establishment is required to remediate a discharge at or from his or her operations. However, the impact would be the same as the impact to any other entity with a similar discharge. The remediation standards for discharges, which are applicable to all sites, will ensure that any remedial action conducted at an agricultural establishment is protective of public health and safety. The proposed rules provide the State's standards for the remediation of all sites without regard to the origin of the discharge or the use of the site.

Regulatory Flexibility Analysis

In accordance with the Regulatory Flexibility Act (the Act), N.J.S.A. 52:14B-16 et seq., the Department has determined that the proposed amendments to the Remediation Standards may have an impact on small businesses as defined in that Act. The Department requires discharges of contaminants at contaminated sites to be remediated to levels that are protective of public health and safety and the environment. Small businesses will be affected by the proposed new rules, amendments, and repeals, to the extent that these businesses are persons responsible for remediating a contaminated site, or are otherwise regulated under the Industrial Site Recovery Act, N.J.S.A. 13:1K-6 et seq., the New Jersey Underground Storage of Hazardous Substances Act, N.J.S.A. 58:10A-21 et seq., or the Spill Compensation and Control Act, N.J.S.A. 58:10-23.11a et seq. The Remediation Standards do not directly compel any recordkeeping or reporting requirements. The various compliance requirements, associated costs, and other impacts to small businesses are discussed in the Summary and Economic Impact above.

The need to remediate a site is based on the contamination present, regardless of the type of business involved. Since a discharge of a hazardous substance endangers public health, safety, and welfare, and cannot be correlated to the size of the business, there is no differentiation in the requirements by the size of a business, and the rules concerning site remediation do not exempt small businesses. Therefore, there are no exemptions from the proposed rules for small businesses.

Housing Affordability Impact Analysis

In accordance with N.J.S.A. 52:14B-4, the Department has evaluated the proposed new rules, amendments, and repeals to determine their impact, if any, on the affordability of housing. The proposed rules affect the degree to which contaminated properties must be remediated; however, the underlying requirement to remediate contamination remains. Therefore, it is extremely unlikely that the proposed rules will evoke a change in the average costs associated with housing in the State.

Smart Growth Development Impact Analysis

In accordance with N.J.S.A. 52:14B-4.1b, the Department has evaluated the proposed amendments to determine the impacts, if any, on housing production in Planning Areas 1 or 2, or within designated centers, under the State Development and Redevelopment Plan. The proposed new rules, amendments, and repeals do not directly involve land use policies or infrastructure development. The proposed rules address remediation of contamination of properties, some of which are or may be used for housing; however, the underlying statutory requirement to remediate contamination remains. The Department anticipates that it is extremely unlikely that the rules will evoke a change in housing production in Planning Areas 1 or 2, or within designated centers.

Racial and Ethnic Community Criminal Justice and Public Safety Impact

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The Department has evaluated this rulemaking and determined that it will not have an impact on pretrial detention, sentencing, probation, or parole policies concerning adults and juveniles in the State. Accordingly, no further analysis is required.

Full text of the rules proposed for repeal may be found in the New Jersey Administrative Code at N.J.A.C. 7:26D-4.2, 4.3, 6.2, 7.1, 7.3, and 7.5; and 7:26D Appendices 1 through 6.

Full text of the proposed new rules and amendments follows (additions indicated in boldface **thus**; deletions indicated in brackets [thus]):

CHAPTER 26D

REMEDIATION STANDARDS

SUBCHAPTER 1. GENERAL INFORMATION

7:26D-1.1 Purpose

[(a)] This chapter implements the [provisions of the] Brownfield and Contaminated Site Remediation Act, N.J.S.A. 58:10B-1[.1] et seq., and other statutes, by establishing [minimum standards for the remediation of contaminated ground water and surface water, and by establishing the minimum residential direct contact and non-residential direct contact soil] remediation standards **for ground water, surface water, soil, soil leachate, and indoor air**.

[(b) This chapter does not establish the minimum impact to ground water soil remediation standards; these standards shall be developed on a site-by-site basis, pursuant to the

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Department's authority under N.J.S.A. 58:10B-12a and the Department's Soil Remediation Standards Guidance for Impact to Ground Water available at www.nj.gov/dep/srp/srra/regs/guidance.htm.

(c) This chapter supplements the requirements in the Technical Requirements for Site Remediation rules, N.J.A.C. 7:26E.]

7:26D-1.2 Scope

(a) [Except as provided in N.J.A.C. 7:26D-1.1(b) and unless] **Unless** otherwise provided by rule or statute, this chapter shall constitute the rules of the Department concerning [minimum] standards for the remediation of **contaminants in** ground water, surface water**,** [and] soil**, soil leachate, and indoor air**.

(b) Remediating ground water, surface water, [or] soil**, or indoor air** to any applicable **remediation** standard set forth in this chapter shall not relieve any person from:

1. Complying with more stringent requirements or provisions imposed under any other Federal, State, or local applicable statutes**, rules,** or regulations; **and**

[2. Complying with any impact to ground water soil remediation standard established by the Department as provided in N.J.A.C. 7:26D-1.1(b); and]

[3.] **2.** Obtaining any and all permits required by Federal, State**,** or local statutes**, rules,** or regulations.

(c)-(e) (No change.)

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7:26D-1.4 Applicability

(a) [Except as provided in N.J.A.C. 7:26D-1.1(b), this] **This** chapter establishes the [minimum] remediation standards for ground water, surface water**,** [and] soil**, soil leachate, and indoor air** for [any] contaminated site**s** in New Jersey including, without limitation, those sites subject to:

1. – 10. (No change.)

[(b) The requirements of this chapter shall be applied pursuant to N.J.A.C. 7:26E-1.5(c) regardless of whether remediation is conducted with Department oversight pursuant to N.J.A.C. 7:26C.]

(b) The person responsible for conducting the remediation shall comply with the remediation standards set forth in this chapter, except as provided in (b)1, 2, and 3 below. The exceptions provided in (b)1, 2, and 3 below may be applied only to an area of concern that is identified in a remedial action workplan or remedial action report.

1. The person responsible for conducting the remediation may use a standard or criterion the Department developed under N.J.S.A. 58:10B-12a, or other authority, prior to June 2, 2008, if:

i. The standard or criterion is not greater by an order of magnitude than the otherwise applicable remediation standard pursuant to this chapter;

ii. A remedial action workplan or a remedial action report containing standards or criteria developed for the site under N.J.S.A. 58:10B-12a, or other authority, was submitted to the Department before December 2, 2008;

iii. The remedial action workplan or remedial action report was either approved by the Department or certified by a licensed site remediation professional; and

iv. The person responsible for conducting the remediation completes the remedial action within the applicable remedial action regulatory timeframe pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-5.8.

2. The person responsible for conducting the remediation may use a remediation standard that was in effect between June 2, 2008, and September 17, 2017, which the Department adopted or developed under N.J.S.A. 58:10B-12a, or other authority, if:

i. The standard is not greater by an order of magnitude than the otherwise applicable remediation standard pursuant to this chapter;

ii. A remedial action workplan or a remedial action report containing standards or criteria developed for the site under N.J.S.A. 58:10B-12a, or other authority, was submitted to the Department between December 2, 2008, and March 17, 2018;

iii. The remedial action workplan or remedial action report was either approved by the Department or certified by a licensed site remediation professional; and

iv. The person responsible for conducting the remediation completes the remedial action within the applicable remedial action regulatory timeframe pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-5.8.

3. The person responsible for conducting the remediation may use a remediation standard the Department adopted or developed pursuant to N.J.S.A. 58:10B-12a, or

other authority, that was in effect between September 18, 2017, and (the effective date of this chapter); if:

i. The standard is not greater by an order of magnitude than the otherwise applicable remediation standard pursuant to this chapter;

ii. A remedial action workplan or a remedial action report containing standards or criteria developed for the site under N.J.S.A. 58:10B-12a was submitted to the Department between March 18, 2018, and (six months after the effective date of this chapter);

iii. The remedial action workplan or remedial action report was either approved by the Department or certified by a licensed site remediation professional; and

iv. The person responsible for conducting the remediation completes the remedial action within the applicable remedial action regulatory timeframe pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-5.8.

(c) (No change.)

7:26D-1.5 Definitions

The following words and terms, when used in this chapter, shall have the following meanings unless the context clearly indicates otherwise:

"Alternative remediation standard" or "ARS" means a [residential use or non-residential use soil] remediation standard that is established using [site specific] **site-specific** factors

following the procedures set forth [in] **at** N.J.A.C. 7:26D-[7]**8 and 7:26D** Appendices [5 and] 6, [pursuant to this chapter] **7, 8, and 9**.

"Area of concern" has the same meaning as the definition of the term in the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-1.8.

...

"Criterion" or "criteria" means, for the ingestion-dermal, inhalation, and vapor intrusion exposure pathways, the health-based value(s) that is (are) derived from the equations contained at N.J.A.C. 7:26D Appendices 2, 3, and 5 using the applicable chemical and physical properties of contaminants contained at N.J.A.C. 7:26D Appendix 10 and toxicity factors contained at N.J.A.C. 7:26D Appendix 11. For the migration to ground water exposure pathway, "criterion" or "criteria" means the soil-water partitioning value(s) that are derived from N.J.A.C. 7:26D Appendix 4, Equations 1 through 4, using the applicable chemical and physical properties of contaminants contained at N.J.A.C. 7:26D Appendix 10.

...

"Exposure pathway[s]" means the [methods by which humans can] **routes by which contaminants in soil, water, or other media** come [into] **in** contact with [contamination including, but not limited to,] **humans. Examples include** the ingestion-dermal exposure pathway [and]**,** the inhalation exposure pathway**, the migration to ground water exposure pathway, and the vapor intrusion exposure pathway**.

"Extractable petroleum hydrocarbons" or "EPH" means extractable aliphatic and aromatic petroleum hydrocarbons identified using the Department's "Extractable Petroleum Hydrocarbons Methodology," found at https://nj.gov/dep/srp/guidance/srra/eph_method.pdf. EPH includes, but is not limited to, No. 2 heating oil and diesel fuel (Category 1), and heavier petroleum products (Category 2), but excludes the lighter petroleum products including gasoline and mineral spirits.

"Ground water" means ground water as defined pursuant to the Ground Water Quality Standards at N.J.A.C. 7:9C-[1.6, which includes Class I, Class II and Class III ground water]**1.4**.

"Ground water quality criteria" means any [human health-based] ground water quality criteria as defined pursuant to the Ground Water Quality Standards at N.J.A.C. 7:9C-[1.6]**1.4**.

[“Impact to ground water remediation standard” means a vadose zone soil remediation standard established or developed by the Department pursuant to its authority under N.J.S.A. 58:10B-12a that is designed to limit the amount of contaminant that leaches from the vadose zone to ground water such that the resulting ground water concentration will not exceed the applicable ground water remediation standard.]

"Ingestion-dermal exposure pathway" means [the process by which humans can come into] **an exposure pathway involving potential human** contact with [contamination] **contaminants** through [the direct] **incidental** ingestion of [contamination and the absorption of contamination through the skin] **soil and through dermal contact with soil**.

"Inhalation exposure pathway" means [the process by which humans can come into] **an exposure pathway involving potential human** contact with [contamination] **contaminants** through the inhalation of [contamination] **particulates or vapors, or a combination of particulates and vapors, emanating from contaminated soil**. **This pathway is distinct from the vapor intrusion exposure pathway.**

["Non-residential use" means an exposure assumption based on exposure of adult outdoor workers to contaminated media during an eight-hour work day, 225 days a year, for 25 years.

"Non-residential direct contact soil remediation standard" means a soil remediation standard for the ingestion-dermal and inhalation exposure pathways established or developed pursuant to this chapter that is designed to protect human health at non-residential use sites.]

"Interim remediation standard" means a remediation standard that is established pursuant to N.J.A.C. 7:26D-6.

"Migration to ground water exposure pathway" means an exposure pathway involving the migration of contaminants in the vadose zone to ground water and subsequent potential human exposure through the ingestion of ground water.

"Nonresidential" or "NR" means used for commercial or industrial purposes.

"Person responsible for conducting the remediation" means [any] **the** person **responsible for conducting the remediation as** defined [as such pursuant to] **in** the Administrative Requirements for the Remediation of Contaminated Sites [rules,] at N.J.A.C. 7:26C-1.3.

...

["Practical quantitation level" or "PQL" means a practical quantitation level or PQL as defined pursuant to Technical Requirements for Site Remediation rules at N.J.A.C. 7:26E-1.8.]

"Regional natural background level" means the concentration of a contaminant consistently present in the environment [in] **of** the region of the site and which has not been influenced by localized human activities.

"Remediation" or "remediate" means remediation or remediate as defined pursuant to the Technical Requirements for Site Remediation [rules] at N.J.A.C. 7:26E-1.8.

"Remediation standard[s]" means the combination of **a** numeric standard[s] that establish[es] a level or concentration, and **a** narrative standard[s]**, as appropriate**, to which **a** contaminant[s] must be treated, removed**,** or otherwise cleaned for soil, **soil leachate,** ground water**,** [or] surface water**, or indoor air**, as established by [the Department pursuant to the Brownfield and Contaminated Sites Remediation Act at N.J.S.A. 58:10B-12 and] this chapter.

["Residential direct contact soil remediation standard" means a soil remediation standard for the ingestion-dermal and inhalation exposure pathways established or developed pursuant to this chapter that is designed to protect human health at residential use sites, schools (pre-K-12) and childcare centers.

"Residential use" means a land use scenario based on exposure to contaminated media for 24 hours a day, 350 days a year for 30 years by children and adults living on a site.]

"Reporting limit" means a reporting limit as defined pursuant to the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-1.8.

"Residential" means used for residences, private and public schools as defined at N.J.S.A. 18A:1-1, charter schools established pursuant to N.J.S.A. 18A:36A-1 et seq., and childcare centers licensed pursuant to N.J.S.A. 30:5B-1 et seq.

...

"Surface Water Quality Standards" has the same meaning as the definition of the term at N.J.A.C. 7:9B-1.4.

...

"Vapor intrusion exposure pathway" is an exposure pathway involving potential human contact with contaminants through the inhalation of contaminated indoor air resulting from the migration of volatile contaminants from the subsurface into buildings. This pathway is distinct from the inhalation exposure pathway.

SUBCHAPTER 2. [MINIMUM] GROUND WATER REMEDIATION STANDARDS

7:26D-2.1 Purpose

This subchapter establishes the [minimum] remediation standards for ground water.

7:26D-2.2 [Minimum ground] **Ground** water remediation standards

(a) The [minimum] remediation standards [to which] **for** ground water [shall be remediated] are:

1. – 3. (No change.)

4. For all ground water, regardless of classification, each of the following narrative ground water remediation standards, as applicable:

i. – iv. (No change.)

v. The free and residual product removal, treatment, or containment requirements of N.J.A.C. 7:26E-5.1(e); **and**

vi. The contaminants have not migrated to the ground surface, structures, or air in concentrations [that pose a threat to human health; and] **in excess of a remediation standard.**

[vii. The following factors, as applicable on a site-specific basis, for selecting an appropriate ground water remedial action:

(1) The location of the contaminated site relative to ground water use;

(2) The potential human and environmental exposure to the ground water contamination;

(3) The present, projected, and potential ground water use at the site and in the area surrounding the site over the 25 years after the selection of the ground water remedy;

(4) The ambient ground water quality at the site and in the area surrounding the site resulting from both human activities and natural conditions; and

(5) The physical and chemical characteristics of the contaminants of concern.

(b) The Department shall not approve an alternative ground water remediation standard that is based on a site-specific risk assessment.]

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SUBCHAPTER 3. [MINIMUM] SURFACE WATER REMEDIATION STANDARDS

7:26D-3.1 Purpose

This subchapter establishes the [minimum] remediation standards for surface water.

7:26D-3.2 [Minimum surface] **Surface** water remediation standards

(a) The [minimum] remediation standards for surface water are:

1. The numeric New Jersey Surface Water Quality Standards, N.J.A.C. 7:9B-1.14(c) [and (d)] **through (h)**; and

2. The following narrative surface water remediation standards:

i. (No change.)

ii. The [narrative] surface water quality criteria [in] **at** N.J.A.C. 7:9B-1.14**(a) and (b)**;

iii. The remediation requirements [in] **at** N.J.A.C. 7:26E-1 through 5 in order to both:

(1) (No change.)

(2) Limit additional risks posed by the contamination to the public health and safety and to the environment; **and**

iv. The free and residual product removal, treatment, or containment requirements of N.J.A.C. 7:26E-5.1(e)[; and]**.**

[v. The following narrative criteria, as applicable on a site-specific basis, for selecting an appropriate surface water remedial action:

(1) The location of the contaminated site relative to surface water use;

(2) The potential human and environmental exposure to the surface water contamination;

(3) The present and projected surface water use at the site and in the area surrounding the site;

(4) The ambient ground water quality at the site and in the area surrounding the site resulting from both human activities and natural conditions; and

(5) The physical and chemical characteristics of the contaminants of concern.

(b) The Department shall not approve an alternative surface water remediation standard that is based on a site-specific risk assessment.]

SUBCHAPTER 4. [MINIMUM] SOIL **AND SOIL LEACHATE** REMEDIATION STANDARDS

7:26D-4.1. Purpose

[(a)] This subchapter establishes [minimum soil] remediation standards[, including:] **for soil and soil leachate.**

[1. Residential direct contact soil remediation standards; and

2. Non-residential direct contact soil remediation standards.]

7:26D-4.2 Soil remediation standards for the ingestion-dermal exposure pathway

(a) The soil remediation standard for the ingestion-dermal exposure pathway for each contaminant listed at N.J.A.C. 7:26D Appendix 1, Tables 1 and 2, is:

1. The more stringent value of the carcinogenic or noncarcinogenic ingestion-dermal human health-based criterion; or

2. The reporting limit, if the reporting limit is greater than the value determined in (a)1 above.

(b) The ingestion-dermal human health-based criteria at N.J.A.C. 7:26D Appendix 1, Tables 1 and 2, incorporated herein by reference, are the residential and nonresidential human health-based criteria for the ingestion-dermal exposure pathway, based on the equations, data sources, and conventions provided at N.J.A.C. 7:26D Appendix 2, incorporated herein by reference, using the data provided at N.J.A.C. 7:26D Appendices 10 and 11, incorporated herein by reference.

(c) N.J.A.C. 7:26D Appendix 1, Table 1 shall be used for sites where the anticipated use is residential. N.J.A.C. 7:26D Appendix 1, Table 2 shall be used for sites where the anticipated use is nonresidential.

7:26D-4.3 Soil remediation standards for the inhalation exposure pathway

(a) The soil remediation standard for the inhalation exposure pathway for each contaminant listed at N.J.A.C. 7:26D Appendix 1, Tables 3 and 4, is:

1. The more stringent value of the carcinogenic or noncarcinogenic inhalation human health-based criterion; or

2. The reporting limit, if the reporting limit is greater than the value determined in (a)1 above.

(b) The inhalation human health-based criteria at N.J.A.C. 7:26D Appendix 1, Tables 3 and 4, incorporated herein by reference, are the residential and nonresidential human health-based criteria for the inhalation exposure pathway, based on the equations, data sources, and conventions provided at N.J.A.C. 7:26D Appendix 3, incorporated herein by reference, using the data provided at N.J.A.C. 7:26D Appendices 10 and 11, incorporated herein by reference.

(c) N.J.A.C. 7:26D Appendix 1, Table 3 shall be used for sites where the anticipated use is residential. N.J.A.C. 7:26D 1, Table 4 shall be used for sites where the anticipated use is nonresidential.

7:26D-4.4 Soil and soil leachate remediation standards for the migration to ground water exposure pathway

(a) The soil remediation standard for the migration to groundwater exposure pathway for each contaminant listed at N.J.A.C. 7:26D Appendix 1, Table 5 is the greater of:

1. The migration to ground water soil criterion; or

2. The reporting limit.

(b) The migration to ground water soil criteria at N.J.A.C. 7:26D Appendix 1, Table 5, incorporated herein by reference, are based on the equations, data sources, and conventions provided at N.J.A.C. 7:26D Appendix 4, Equations 1 through 4, incorporated herein by reference, using the data at N.J.A.C. 7:26D Appendix 10, incorporated herein by reference.

(c) The soil leachate remediation standards for the migration to ground water exposure pathway at N.J.A.C. 7:26D Appendix 1, Table 6, incorporated herein by reference, are based upon the equations, data sources, and conventions provided at N.J.A.C. 7:26D Appendix 4, Equation 5, incorporated herein by reference.

SUBCHAPTER 5. INDOOR AIR REMEDIATION STANDARDS

7:26D-5.1 Purpose

This subchapter establishes remediation standards for indoor air for the vapor intrusion exposure pathway.

7:26D-5.2 Indoor air remediation standards

(a) The indoor air remediation standards for the vapor intrusion exposure pathway for each contaminant listed at N.J.A.C. 7:26D Appendix 1, Tables 7 and 8, incorporated herein by reference, were developed as follows:

1. The more stringent value of the carcinogenic or noncarcinogenic indoor air human health-based criterion; or

2. The reporting limit, if the reporting limit is greater than the value determined in (a)1 above.

(b) N.J.A.C. 7:26D Appendix 1, Table 7, shall be used for sites where the anticipated use is residential. N.J.A.C. 7:26D Appendix 1, Table 8, shall be used for sites where the anticipated use is nonresidential.

(c) The methodology used to develop the indoor air remediation criteria is provided at N.J.A.C. 7:26D Appendix 5, incorporated herein by reference.

SUBCHAPTER [5.] **6.** INTERIM [SOIL] REMEDIATION STANDARDS

7:26D-[5.1]**6.1** Purpose

[Except as provided at N.J.A.C. 7:26D-1.1(b), this] **This** subchapter sets forth the procedures that the Department will use to establish interim [soil] remediation standards.

7:26D-[5.2]**6.2** [Development of an interim soil] **Interim** remediation standard**s**

(a) The Department may establish an interim remediation standard for [soil]**:**

1. Soil, soil leachate, and indoor air when a contaminant is not listed [in] **at N.J.A.C. 7:26D** Appendix 1[, Tables 1A, or 1B of this chapter.]**; and**

2. Ground water when a contaminant is not listed in the Ground Water Quality Standards, N.J.A.C. 7:9C Appendix, Table 1.

[(b) An interim remediation standard shall be developed for soil as follows:

1. For the ingestion-dermal pathway, using the procedures set forth in Appendix 2; and

2. For the inhalation pathway, using the procedures set forth in Appendix 3.]

[(c)] **(b)** [For the two pathways listed in (b) above, the] **The** person responsible for conducting [a] **the** remediation may request that the Department develop an interim [soil] remediation standard [under this section] **pursuant to this subchapter and shall use only a Department-developed interim remediation standard**.

(c) An interim remediation standard shall be developed as follows:

1. For ground water, using the procedures set forth in the Ground Water Quality Standards at N.J.A.C. 7:9C-1.7(c);

2. For soil:

i. For the ingestion-dermal exposure pathway, using the procedures set forth at N.J.A.C. 7:26D Appendix 2, incorporated herein by reference;

ii. For the inhalation exposure pathway, using the procedures set forth at N.J.A.C. 7:26D Appendix 3, incorporated herein by reference; or

iii. For the migration to ground water exposure pathway, using procedures set forth at N.J.A.C. 7:26D Appendix 4, incorporated herein by reference; or

3. For indoor air for the vapor intrusion exposure pathway, using procedures set forth at N.J.A.C. 7:26D Appendix 5, incorporated herein by reference.

7:26D-[5.3]**6.3** Publication **and promulgation** of interim [soil] remediation standards[; promulgation]

(a) The Department shall publish on its [web site] **website** a listing of all interim [soil] remediation standards developed pursuant to this chapter and the technical basis used in their derivation.

(b) (No change.)

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SUBCHAPTER [6.] **7.** UPDATING [SOIL] REMEDIATION STANDARDS

7:26D-[6.1]**7.1** Purpose

This subchapter sets forth the procedures that the Department will use to update remediation standards [for soil developed pursuant to this chapter].

7:26D-7.2 Procedures for updating remediation standards

(a) The Department shall update a remediation standard for soil or indoor air at N.J.A.C. 7:26D Appendix 1 when:

1. The USEPA revises toxicity information contained in the Integrated Risk Information System (IRIS) database;

2. The Department uses new or revised toxicity information developed by the New Jersey Drinking Water Quality Institute when promulgating a new or revised maximum contaminant level (MCL) for a drinking water constituent;

3. The Department uses new or revised toxicity information when promulgating a new or revised ground water quality standard; or

4. The USEPA revises or replaces its Integrated Environmental Uptake Biokinetic (IEUBK) Model and Adult Lead Model (ALM) and input parameters for lead.

(b) The Department shall update a soil and a soil leachate remediation standard for the migration to ground water exposure pathway at N.J.A.C. 7:26D Appendix 1 when a ground water quality criterion is updated pursuant to the Ground Water Quality Standards at N.J.A.C. 7:9C-1.7(c)5.

(c) When the Department develops an updated remediation standard, the Department shall post on its website at https://www.nj.gov/dep/rules/adminchg.html and publish in the New Jersey Register a notice of administrative change. The notice of administrative change shall identify the remediation standard to be updated including the relevant media and exposure pathway, the contaminant, the basis for the administrative change, and the revised criterion to be listed at N.J.A.C. 7:26D Appendix 1.

(d) An updated remediation standard shall be effective on the date the notice of administrative change is filed with the Office of Administrative Law.

(e) An updated remediation standard shall be applied to all sites except, in lieu of the updated remediation standard established pursuant to this subchapter, the person responsible for conducting the remediation may continue to use a remediation standard that is specified in a remedial action workplan or remedial action report for a site, provided that:

1. The remedial action workplan or remedial action report is submitted no later than six months after the effective date of the updated standard;

2. The remedial action workplan or remedial action report is approved by the Department or is certified by a licensed site remediation professional;

3. The remediation standard specified in the remedial action workplan or remedial action report for a given contaminant is not greater by an order of magnitude than the updated remediation standard; and

4. The remedial action shall comply with the applicable regulatory timeframes pursuant to the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-5.

SUBCHAPTER [7.] **8.** ALTERNATIVE [SOIL] REMEDIATION STANDARDS

7:26D-8.1 Purpose

(a) This subchapter sets forth the procedures for the development and approval of alternative remediation standards for:

1. Soil for the ingestion-dermal exposure pathway and inhalation exposure pathway;

2. Soil and soil leachate for the migration to ground water exposure pathway; and

3. Indoor air for the vapor intrusion exposure pathway.

7:26D-[7.2]**8.2** Applicability

An alternative [soil] remediation standard developed pursuant to this [chapter may only be numeric and may only be used] **subchapter in lieu of a remediation standard established by N.J.A.C. 7:26D-2, 3, 4, 5, or 6, shall be used only** at the site **or area of concern** for which it is **developed and** approved [and is not applicable at any other site].

7:26D-8.3 Development of an alternative remediation standard

(a) An alternative remediation standard for a site or area of concern:

1. May be developed for soil, for the following exposure pathways:

i. Ingestion-dermal exposure pathway using the procedures at N.J.A.C. 7:26D Appendix 6, incorporated herein by reference;

ii. Inhalation exposure pathway using the procedures at N.J.A.C. 7:26D Appendix 7, incorporated herein by reference; and

iii. Migration to ground water exposure pathway using the procedures at N.J.A.C. 7:26D Appendix 8, incorporated herein by reference;

2. May be developed for indoor air, for the vapor intrusion exposure pathway, using the procedures at N.J.A.C. 7:26D Appendix 9, incorporated herein by reference.

(b) The Department may, upon its own initiative and in accordance with N.J.S.A. 58:10B-12.f(2), require the development and use of an alternative remediation standard for a particular contaminant for a particular site or area of concern that is either more or less stringent than the remediation standards established by this chapter.

(c) The person responsible for conducting the remediation who develops an alternative remediation standard that requires prior approval from the Department shall follow the approval process outlined at N.J.A.C. 7:26D-8.4.

(d) The person responsible for conducting the remediation who develops an alternative remediation standard that does not require prior approval from the Department shall follow the process outlined at N.J.A.C. 7:26D-8.5.

(e) In accordance with the Site Remediation Reform Act, at N.J.S.A. 58:10C-21, the alternative remediation standards developed pursuant to this subchapter shall be subject

to the Department inspection and review process as described in the Site Remediation Reform Act at N.J.S.A. 58:10C-21a.

7:26D-[7.4]**8.4** [Alternative soil remediation standards application and approval] **Approval** process **for alternative remediation standards requiring prior approval from the Department**

(a) [The] **Except as provided at N.J.A.C. 7:26D-8.5, the** person responsible for conducting the remediation [may seek Department] **shall obtain prior** approval **from the Department, in accordance with (b) and (c) below,** for an alternative [soil] remediation standard [based on the criteria in N.J.A.C. 7:26D-7.3(a) and (b) by submitting the completed application on a form, found on the Department's website at www.nj.gov/dep/srp/srra/forms, in accordance with (b) below] **developed pursuant to this subchapter before using the alternative remediation standard at a specific site or area of concern**.

(b) For each proposed alternative remediation standard, the person responsible for conducting the remediation shall collect and submit to the Department, along with the appropriate form(s) found on the Department's website at www.nj.gov/dep/srp/srra/forms, the information indicated for the proposed alternative remediation standard as described at N.J.A.C. 7:26D Appendices 6 through 9, incorporated herein by reference.

[(b)] **(c)** The Department [will] **shall** review the [application to develop an alternative remediation standard and send the person responsible for conducting the remediation the

following,] **information the person responsible for conducting the remediation submits in accordance with (b) above, and shall respond** as [applicable] **follows**:

1. If the Department determines that the [application is complete and that the proposed alternative soil remediation standard is protective of human health and safety and the environment,] **submitted information is acceptable, then** the Department [will] **shall** provide the person responsible for conducting the remediation with a written approval **for the use** of the alternative soil remediation standard [for that] **at the specific** site or area of concern; **or**

2. If the Department determines that the [application] **submitted information** is deficient, **then** the Department [will] **shall** provide [written] comments to the person responsible for conducting the remediation describing the deficiencies [in the application], in which case [the person may submit a revised application addressing the deficiencies to the Department; or]**:**

[3. If the Department determines that the proposed alternative soil remediation is not protective of human health, the Department will provide the person responsible for conducting the remediation with written notification of the denial of the application. The person shall not apply the denied alternative remediation standard to the contaminated site or area of concern.]

i. The person responsible for conducting the remediation may correct the deficiencies and may resubmit the information to the Department for its review pursuant to (c) above; or

ii. The person responsible for conducting the remediation may withdraw the request for approval of a proposed alternative remediation standard.

(d) The person responsible for conducting the remediation shall not use the proposed alternative remediation standard if that person does not correct a deficiency noted by the Department pursuant to N.J.A.C. 7:26D-8.4(c)2.

7:26D-8.5 Process for the development of alternative remediation standards not requiring prior approval by the Department

(a) When the person responsible for conducting the remediation is not required to obtain prior approval from the Department for the implementation of an alternative remediation standard developed pursuant to this subchapter, the person responsible shall:

1. For each proposed alternative remediation standard, collect the information indicated for each applicable exposure pathway as described at N.J.A.C. 7:26D Appendices 6, 7, 8, and 9, incorporated herein by reference; and

2. Submit to the Department the information described in (a)1 above with the applicable remedial phase report or workplan pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E.

APPENDIX 1

REMEDIATION STANDARDS TABLES

Table 1 – Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway -

Residential (mg/kg) (All numeric values are rounded to two significant figures)

Contaminant	CAS No.	Residential Carcinogenic Ingestion-Dermal Human Health-based Criterion	Residential Noncarcinogenic Ingestion-Dermal Human Health-based Criterion	Reporting Limit	Soil Remediation Standard Ingestion-Dermal – Residential
Acenaphthene	83-32-9	NA	3,600	0.17	3,600
Acetone (2-Propanone)	67-64-1	NA	70,000	0.010	70,000
Acetophenone	98-86-2	NA	7,800	0.33	7,800
Aldrin	309-00-2	0.032	1.9	0.0017	0.032
Aluminum (total)	7429-90-5	NA	78,000	20	78,000
Anthracene	120-12-7	NA	18,000	0.17	18,000
Antimony (total)	7440-36-0	NA	31	1.0	31
Arsenic (total)	7440-38-2	0.43	22	0.50	19[1]
Atrazine	1912-24-9	NA	220	0.33	220
Barium (total)	7440-39-3	NA	16,000	5.0	16,000
Benzaldehyde	100-52-7	NA	170	0.33	170
Benzene	71-43-2	3.0	310	0.0050	3.0
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	5.1	NA	0.17	5.1
Benzo(a)pyrene	50-32-8	0.51	NA	0.17	0.51
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	5.1	NA	0.17	5.1
Benzo(k)fluoranthene	207-08-9	51	NA	0.17	51
Beryllium	7440-41-7	NA	160	0.50	160
1,1'-Biphenyl	92-52-4	87	39,000	0.17	87
Bis(2-chloroethoxy)methane	111-91-1	NA	190	0.17	190
Bis(2-chloroethyl)ether	111-44-4	0.63	NA	0.33	0.63
Bis(2-ethylhexyl)phthalate	117-81-7	39	1,300	0.17	39
Bromodichloromethane (Dichlorobromomethane)	75-27-4	11	1,600	0.0050	11
Bromoform	75-25-2	88	1,600	0.0050	88
Bromomethane (Methyl bromide)	74-83-9	NA	110	0.0050	110
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	NA	47,000	0.010	47,000
Butylbenzyl phthalate	85-68-7	290	13,000	0.17	290
Cadmium	7440-43-9	NA	71	0.50	71
Caprolactam	105-60-2	NA	32,000	0.33	32,000
Carbon disulfide	75-15-0	NA	NA	0.0050	NA

Carbon tetrachloride	**56-23-5**	**7.6**	**310**	**0.0050**	**7.6**
Chlordane (alpha and gamma forms summed)	**57-74-9**	**0.27**	**36**	**0.0017**	**0.27**
4-Chloroaniline	**106-47-8**	**2.7**	**250**	**0.17**	**2.7**
Chlorobenzene	**108-90-7**	**NA**	**510**	**0.0050**	**510**
Chloroethane (Ethyl chloride)	**75-00-3**	**NA**	**NA**	**0.0050**	**NA**
Chloroform	**67-66-3**	**NA**	**780**	**0.0050**	**780**
Chloromethane (Methyl chloride)	**74-87-3**	**NA**	**NA**	**0.0050**	**NA**
2-Chloronaphthalene	**91-58-7**	**NA**	**4,800**	**0.17**	**4,800**
2-Chlorophenol (o-Chlorophenol)	**95-57-8**	**NA**	**390**	**0.17**	**390**
Chrysene	**218-01-9**	**510**	**NA**	**0.17**	**510**
Cobalt (total)	**7440-48-4**	**NA**	**23**	**0.50**	**23**
Copper (total)	**7440-50-8**	**NA**	**3,100**	**1.0**	**3,100**
Cyanide	**57-12-5**	**NA**	**47**	**0.50**	**47**
Cyclohexane	**110-82-7**	**NA**	**NA**	**0.0050**	**NA**
4,4'-DDD (p,p'-TDE)	**72-54-8**	**2.3**	**NA**	**0.0033**	**2.3**
4,4'-DDE (p,p'-DDX)	**72-55-9**	**1.6**	**NA**	**0.0033**	**1.6**
4,4'-DDT	**50-29-3**	**1.9**	**37**	**0.0033**	**1.9**
Dibenz(a,h)anthracene	**53-70-3**	**0.51**	**NA**	**0.17**	**0.51**
Dibromochloromethane (Chlorodibromomethane)	**124-48-1**	**8.3**	**1,600**	**0.0050**	**8.3**
1,2-Dibromo-3-chloropropane	**96-12-8**	**0.87**	**16**	**0.0050**	**0.87**
1,2-Dibromoethane (Ethylene dibromide)	**106-93-4**	**0.35**	**700**	**0.0050**	**0.35**
1,2-Dichlorobenzene (o-Dichlorobenzene)	**95-50-1**	**NA**	**6,700**	**0.0050**	**6,700**
1,3-Dichlorobenzene (m-Dichlorobenzene)	**541-73-1**	**NA**	**6,700**	**0.0050**	**6,700**
1,4-Dichlorobenzene (p-Dichlorobenzene)	**106-46-7**	**NA**	**780**	**0.0050**	**780**
3,3'-Dichlorobenzidine	**91-94-1**	**1.2**	**NA**	**0.33**	**1.2**
Dichlorodifluoromethane (Freon 12)	**75-71-8**	**NA**	**16,000**	**0.0050**	**16,000**
1,1-Dichloroethane	**75-34-3**	**120**	**16,000**	**0.0050**	**120**
1,2-Dichloroethane	**107-06-2**	**5.8**	**NA**	**0.0050**	**5.8**
1,1-Dichloroethene (1,1-Dichloroethylene)	**75-35-4**	**NA**	**11**	**0.0050**	**11**

1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	**156-59-2**	**NA**	**780**	**0.0050**	**780**
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	**156-60-5**	**NA**	**1,300**	**0.0050**	**1,300**
2,4-Dichlorophenol	**120-83-2**	**NA**	**190**	**0.17**	**190**
1,2-Dichloropropane	**78-87-5**	**19**	**7,000**	**0.0050**	**19**
1,3-Dichloropropene (total)	**542-75-6**	**7.0**	**2,300**	**0.0050**	**7.0**
Dieldrin	**60-57-1**	**0.034**	**3.2**	**0.0033**	**0.034**
Diethylphthalate	**84-66-2**	**NA**	**51,000**	**0.17**	**51,000**
2,4-Dimethylphenol	**105-67-9**	**NA**	**1,300**	**0.17**	**1,300**
Di-n-butyl phthalate	**84-74-2**	**NA**	**6,300**	**0.17**	**6,300**
2,4-Dinitrophenol	**51-28-5**	**NA**	**130**	**0.33**	**130**
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	**25321-14-6**	**0.80**	**NA**	**0.17**	**0.80**
Di-n-octyl phthalate	**117-84-0**	**NA**	**630**	**0.33**	**630**
1,4-Dioxane	**123-91-1**	**7.0**	**2,300**	**0.067**	**7.0**
Endosulfan I and Endosulfan II (alpha and beta) (summed)	**115-29-7**	**NA**	**380**	**0.0033**	**380**
Endrin	**72-20-8**	**NA**	**19**	**0.0033**	**19**
Ethylbenzene	**100-41-4**	**NA**	**7,800**	**0.0050**	**7,800**
Extractable Petroleum Hydrocarbons (Category 1)	**various**	**NA**	**5,300[3]**	**80**	**5,300[3]**
Extractable Petroleum Hydrocarbons (Category 2)	**various**	**NA**	**Sample-specific[4]**	**80**	**Sample-specific[4]**
Fluoranthene	**206-44-0**	**NA**	**2,400**	**0.33**	**2,400**
Fluorene	**86-73-7**	**NA**	**2,400**	**0.17**	**2,400**
alpha-HCH (alpha-BHC)	**319-84-6**	**0.086**	**510**	**0.0017**	**0.086**
beta-HCH (beta-BHC)	**319-85-7**	**0.30**	**NA**	**0.0017**	**0.30**
Heptachlor	**76-44-8**	**0.12**	**32**	**0.0017**	**0.12**
Heptachlor epoxide	**1024-57-3**	**0.060**	**0.82**	**0.0017**	**0.060**
Hexachlorobenzene	**118-74-1**	**0.34**	**51**	**0.17**	**0.34**
Hexachloro-1,3-butadiene	**87-68-3**	**7.0**	**63**	**0.17**	**7.0**
Hexachlorocyclopentadiene	**77-47-4**	**NA**	**380**	**0.33**	**380**
Hexachloroethane	**67-72-1**	**14**	**44**	**0.17**	**14**
n-Hexane	**110-54-3**	**NA**	**4,700**	**-[7]**	**4,700**
2-Hexanone	**591-78-6**	**NA**	**390**	**0.010**	**390**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**5.1**	**NA**	**0.17**	**5.1**
Isophorone	**78-59-1**	**570**	**13,000**	**0.17**	**570**
Isopropylbenzene	**98-82-8**	**NA**	**7,800**	**0.0050**	**7,800**
Lead (total)	**7439-92-1**	**NA**	**NA**	**0.50**	**400[5]**

Lindane (gamma-HCH)(gamma-BHC)	**58-89-9**	**0.49**	**19**	**0.0017**	**0.49**
Manganese (total)	**7439-96-5**	**NA**	**1,900**	**0.50**	**1,900**
Mercury (total)	**7439-97-6**	**NA**	**23**	**0.10**	**23**
Methoxychlor	**72-43-5**	**NA**	**320**	**0.017**	**320**
Methyl acetate	**79-20-9**	**NA**	**78,000**	**0.0050**	**78,000**
Methylene chloride (Dichloromethane)	**75-09-2**	**50**	**470**	**0.0050**	**50**
2-Methylnaphthalene	**91-57-6**	**NA**	**240**	**0.17**	**240**
4-Methyl-2-pentanone (MIBK)	**108-10-1**	**NA**	**6,300**	**0.010**	**6,300**
2-Methylphenol (o-cresol)	**95-48-7**	**NA**	**320**	**0.33**	**320**
4-Methylphenol (p-cresol)	**106-44-5**	**NA**	**630**	**0.33**	**630**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**NA**	**780**	**0.0050**	**780**
Naphthalene	**91-20-3**	**NA**	**2,500**	**0.17**	**2,500**
Nickel (total)	**7440-02-0**	**NA**	**1,600**	**0.50**	**1,600**
4-Nitroaniline	**100-01-6**	**27**	**250**	**0.33**	**27**
Nitrobenzene	**98-95-3**	**NA**	**160**	**0.17**	**160**
N-Nitrosodi-n-propylamine	**621-64-7**	**0.078**	**NA**	**0.17**	**0.17[2]**
N-Nitrosodiphenylamine	**86-30-6**	**110**	**NA**	**0.17**	**110**
2,2'-oxybis (1-chloropropane)	**108-60-1**	**NA**	**3,100**	**0.33**	**3,100**
Pentachlorophenol	**87-86-5**	**1.0**	**250**	**0.33**	**1.0**
Phenol	**108-95-2**	**NA**	**19,000**	**0.33**	**19,000**
Polychlorinated biphenyls (PCBs)	**1336-36-3**	**0.25**	**NA**	**0.030**	**0.25**
Pyrene	**129-00-0**	**NA**	**1,800**	**0.17**	**1,800**
Selenium (total)	**7782-49-2**	**NA**	**390**	**2.5**	**390**
Silver (total)	**7440-22-4**	**NA**	**390**	**0.50**	**390**
Styrene	**100-42-5**	**NA**	**16,000**	**0.0050**	**16,000**
Tertiary butyl alcohol (TBA)	**75-65-0**	**NA**	**1,400**	**0.10**	**1,400**
1,2,4,5-Tetrachlorobenzene	**95-94-3**	**NA**	**19**	**0.17**	**19**
2,3,7,8-Tetrachlorodibenzo-p-dioxin	**1746-01-6**	**NA**	**0.000051**	**0.0000010**	**0.000051[6]**
1,1,2,2-Tetrachloroethane	**79-34-5**	**3.5**	**1,600**	**0.0050**	**3.5**
Tetrachloroethene (PCE) (Tetrachloroethylene)	**127-18-4**	**330**	**470**	**0.0050**	**330**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**NA**	**1,900**	**0.17**	**1,900**
Toluene	**108-88-3**	**NA**	**6,300**	**0.0050**	**6,300**
Toxaphene	**8001-35-2**	**0.49**	**NA**	**0.17**	**0.49**
1,2,4-Trichlorobenzene	**120-82-1**	**NA**	**630**	**0.0050**	**630**
1,1,1-Trichloroethane	**71-55-6**	**NA**	**160,000**	**0.0050**	**160,000**

1,1,2-Trichloroethane	79-00-5	12	310	0.0050	12
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	15	39	0.0050	15
Trichlorofluoromethane (Freon 11)	75-69-4	NA	23,000	0.0050	23,000
2,4,5-Trichlorophenol	95-95-4	NA	6,300	0.20	6,300
2,4,6-Trichlorophenol	88-06-2	49	63	0.20	49
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	76-13-1	NA	NA	0.0050	NA
1,2,4-Trimethylbenzene	95-63-6	NA	780	0.076	780
Vanadium (total)	7440-62-2	NA	390	2.5	390
Vinyl chloride	75-01-4	0.97	230	0.0050	0.97
Xylenes (total)	1330-20-7	NA	12,000	0.0050	12,000
Zinc (total)	7440-66-6	NA	23,000	1.0	23,000

NA – Not applicable because appropriate toxicological information is not available

[1] Standard is based on natural background

[2] Standard set at reporting limit

[3] Special calculation for EPH – see at N113

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[4] Sample-specific calculation using EPH calculator – see at N.J.A.C. 7:26D Appendix 2

[5] Standard based on the Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children

[6] This standard is used for comparison to site soil data that have been converted to sample-specific TCDD-TEQ values through application of the Toxicity Equivalence Factor Methodology (USEPA 2010) and using the WHO 2005 Mammalian Toxic Equivalency Factors (TEFs)

[7] Although n-Hexane does not have a specific reporting limit, quantification is required to be less than the applicable remediation standard

Table 2 – Soil Remediation Standards for the Ingestion-Dermal Exposure Pathway - Nonresidential (mg/kg) (All numeric values are rounded to two significant figures)

Contaminant	CAS No.	Nonresidential Carcinogenic Ingestion-Dermal Human Health-based Criterion	Nonresidential Noncarcinogenic Ingestion-Dermal Human Health-based Criterion	Reporting Limit	Soil Remediation Standard Ingestion-Dermal – Nonresidential
Acenaphthene	83-32-9	NA	50,000	0.17	50,000
Acetone (2-Propanone)	67-64-1	NA	1,200,000	0.010	NA[1]
Acetophenone	98-86-2	NA	130,000	0.33	130,000
Aldrin	309-00-2	0.15	27	0.0017	0.15
Aluminum (total)	7429-90-5	NA	1,300,000	20	NA[1]
Anthracene	120-12-7	NA	250,000	0.17	250,000
Antimony (total)	7440-36-0	NA	520	1.0	520
Arsenic (total)	7440-38-2	2.1	350	0.50	19[2]
Atrazine	1912-24-9	NA	3,200	0.33	3,200
Barium (total)	7440-39-3	NA	260,000	5.0	260,000
Benzaldehyde	100-52-7	NA	910	0.33	910
Benzene	71-43-2	16	5,200	0.0050	16
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	23	NA	0.17	23
Benzo(a)pyrene	50-32-8	2.3	NA	0.17	2.3
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	23	NA	0.17	23
Benzo(k)fluoranthene	207-08-9	230	NA	0.17	230
Beryllium	7440-41-7	NA	2,600	0.50	2,600
1,1'-Biphenyl	92-52-4	450	650,000	0.17	450
Bis(2-chloroethoxy)methane	111-91-1	NA	2,700	0.17	2,700
Bis(2-chloroethyl)ether	111-44-4	3.3	NA	0.33	3.3
Bis(2-ethylhexyl)phthalate	117-81-7	180	18,000	0.17	180
Bromodichloromethane (Dichlorobromomethane)	75-27-4	59	26,000	0.0050	59
Bromoform	75-25-2	460	26,000	0.0050	460
Bromomethane (Methyl bromide)	74-83-9	NA	1,800	0.0050	1,800
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	NA	780,000	0.010	780,000

Butylbenzyl phthalate	**85-68-7**	**1,300**	**180,000**	**0.17**	**1,300**
Cadmium	**7440-43-9**	**NA**	**1,100**	**0.50**	**1,100**
Caprolactam	**105-60-2**	**NA**	**460,000**	**0.33**	**460,000**
Carbon disulfide	**75-15-0**	**NA**	**NA**	**0.0050**	**NA**
Carbon tetrachloride	**56-23-5**	**40**	**5,200**	**0.0050**	**40**
Chlordane (alpha and gamma forms summed)	**57-74-9**	**1.4**	**550**	**0.0017**	**1.4**
4-Chloroaniline	**106-47-8**	**13**	**3,600**	**0.17**	**13**
Chlorobenzene	**108-90-7**	**NA**	**8,400**	**0.0050**	**8,400**
Chloroethane (Ethyl chloride)	**75-00-3**	**NA**	**NA**	**0.0050**	**NA**
Chloroform	**67-66-3**	**NA**	**13,000**	**0.0050**	**13,000**
Chloromethane (Methyl chloride)	**74-87-3**	**NA**	**NA**	**0.0050**	**NA**
2-Chloronaphthalene	**91-58-7**	**NA**	**67,000**	**0.17**	**67,000**
2-Chlorophenol (o-Chlorophenol)	**95-57-8**	**NA**	**6,500**	**0.17**	**6,500**
Chrysene	**218-01-9**	**2,300**	**NA**	**0.17**	**2,300**
Cobalt (total)	**7440-48-4**	**NA**	**390**	**0.50**	**390**
Copper (total)	**7440-50-8**	**NA**	**52,000**	**1.0**	**52,000**
Cyanide	**57-12-5**	**NA**	**780**	**0.50**	**780**
Cyclohexane	**110-82-7**	**NA**	**NA**	**0.0050**	**NA**
4,4'-DDD (p,p'-TDE)	**72-54-8**	**11**	**NA**	**0.0033**	**11**
4,4'-DDE (p,p'-DDX)	**72-55-9**	**7.5**	**NA**	**0.0033**	**7.5**
4,4'-DDT	**50-29-3**	**9.5**	**580**	**0.0033**	**9.5**
Dibenz(a,h)anthracene	**53-70-3**	**2.3**	**NA**	**0.17**	**2.3**
Dibromochloromethane (Chlorodibromomethane)	**124-48-1**	**43**	**26,000**	**0.0050**	**43**
1,2-Dibromo-3-chloropropane	**96-12-8**	**4.5**	**260**	**0.0050**	**4.5**
1,2-Dibromoethane (Ethylene dibromide)	**106-93-4**	**1.8**	**12,000**	**0.0050**	**1.8**
1,2-Dichlorobenzene (o-Dichlorobenzene)	**95-50-1**	**NA**	**110,000**	**0.0050**	**110,000**
1,3-Dichlorobenzene (m-Dichlorobenzene)	**541-73-1**	**NA**	**110,000**	**0.0050**	**110,000**
1,4-Dichlorobenzene (p-Dichlorobenzene)	**106-46-7**	**NA**	**13,000**	**0.0050**	**13,000**
3,3'-Dichlorobenzidine	**91-94-1**	**5.7**	**NA**	**0.33**	**5.7**

Dichlorodifluoromethane (Freon 12)	**75-71-8**	**NA**	**260,000**	**0.0050**	**260,000**
1,1-Dichloroethane	**75-34-3**	**640**	**260,000**	**0.0050**	**640**
1,2-Dichloroethane	**107-06-2**	**30**	**NA**	**0.0050**	**30**
1,1-Dichloroethene (1,1-Dichloroethylene)	**75-35-4**	**NA**	**180**	**0.0050**	**180**
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	**156-59-2**	**NA**	**13,000**	**0.0050**	**13,000**
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	**156-60-5**	**NA**	**22,000**	**0.0050**	**22,000**
2,4-Dichlorophenol	**120-83-2**	**NA**	**2,700**	**0.17**	**2,700**
1,2-Dichloropropane	**78-87-5**	**98**	**120,000**	**0.0050**	**98**
1,3-Dichloropropene (total)	**542-75-6**	**36**	**39,000**	**0.0050**	**36**
Dieldrin	**60-57-1**	**0.16**	**46**	**0.0033**	**0.16**
Diethylphthalate	**84-66-2**	**NA**	**730,000**	**0.17**	**730,000**
2,4-Dimethylphenol	**105-67-9**	**NA**	**18,000**	**0.17**	**18,000**
Di-n-butyl phthalate	**84-74-2**	**NA**	**91,000**	**0.17**	**91,000**
2,4-Dinitrophenol	**51-28-5**	**NA**	**1,800**	**0.33**	**1,800**
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	**25321-14-6**	**3.8**	**NA**	**0.17**	**3.8**
Di-n-octyl phthalate	**117-84-0**	**NA**	**9,100**	**0.33**	**9,100**
1,4-Dioxane	**123-91-1**	**36**	**39,000**	**0.067**	**36**
Endosulfan I and Endosulfan II (alpha and beta) (summed)	**115-29-7**	**NA**	**5,500**	**0.0033**	**5,500**
Endrin	**72-20-8**	**NA**	**270**	**0.0033**	**270**
Ethylbenzene	**100-41-4**	**NA**	**130,000**	**0.0050**	**130,000**
Extractable Petroleum Hydrocarbons (Category 1)	**various**	**NA**	**75,000[3]**	**80**	**75,000[3]**
Extractable Petroleum Hydrocarbons (Category 2)	**various**	**NA**	**Sample-specific[4]**	**80**	**Sample-specific[4]**
Fluoranthene	**206-44-0**	**NA**	**33,000**	**0.33**	**33,000**
Fluorene	**86-73-7**	**NA**	**33,000**	**0.17**	**33,000**
alpha-HCH (alpha-BHC)	**319-84-6**	**0.41**	**7,300**	**0.0017**	**0.41**
beta-HCH (beta-BHC)	**319-85-7**	**1.4**	**NA**	**0.0017**	**1.4**
Heptachlor	**76-44-8**	**0.57**	**460**	**0.0017**	**0.57**
Heptachlor epoxide	**1024-57-3**	**0.28**	**12**	**0.0017**	**0.28**
Hexachlorobenzene	**118-74-1**	**1.6**	**730**	**0.17**	**1.6**
Hexachloro-1,3-butadiene	**87-68-3**	**33**	**910**	**0.17**	**33**
Hexachlorocyclopentadiene	**77-47-4**	**NA**	**5,500**	**0.33**	**5,500**
Hexachloroethane	**67-72-1**	**64**	**640**	**0.17**	**64**
n-Hexane	**110-54-3**	**NA**	**78,000**	**-[7]**	**78,000**

2-Hexanone	591-78-6	NA	6,500	0.010	6,500
Indeno(1,2,3-cd)pyrene	193-39-5	23	NA	0.17	23
Isophorone	78-59-1	2,700	180,000	0.17	2,700
Isopropylbenzene	98-82-8	NA	130,000	0.0050	130,000
Lead (total)	7439-92-1	NA	NA	0.5	800[5]
Lindane (gamma-HCH)(gamma-BHC)	58-89-9	2.3	270	0.0017	2.3
Manganese (total)	7439-96-5	NA	31,000	0.50	31,000
Mercury (total)	7439-97-6	NA	390	0.10	390
Methoxychlor	72-43-5	NA	4,600	0.017	4,600
Methyl acetate	79-20-9	NA	1,300,000	0.0050	NA[1]
Methylene chloride (Dichloromethane)	75-09-2	260	7,800	0.0050	260
2-Methylnaphthalene	91-57-6	NA	3,300	0.17	3,300
4-Methyl-2-pentanone (MIBK)	108-10-1	NA	100,000	0.01	100,000
2-Methylphenol (o-cresol)	95-48-7	NA	4,600	0.33	4,600
4-Methylphenol (p-cresol)	106-44-5	NA	9,100	0.33	9,100
Methyl tert-butyl ether (MTBE)	1634-04-4	NA	13,000	0.0050	13,000
Naphthalene	91-20-3	NA	34,000	0.17	34,000
Nickel (total)	7440-02-0	NA	26,000	0.50	26,000
4-Nitroaniline	100-01-6	130	3,600	0.33	130
Nitrobenzene	98-95-3	NA	2,600	0.17	2,600
N-Nitrosodi-n-propylamine	621-64-7	0.36	NA	0.17	0.36
N-Nitrosodiphenylamine	86-30-6	520	NA	0.17	520
2,2'-oxybis(1-chloropropane)	108-60-1	NA	52,000	0.33	52,000
Pentachlorophenol	87-86-5	4.4	3,200	0.33	4.4
Phenol	108-95-2	NA	270,000	0.33	270,000
Polychlorinated biphenyls (PCBs)	1336-36-3	1.1	NA	0.030	1.1
Pyrene	129-00-0	NA	25,000	0.17	25,000
Selenium (total)	7782-49-2	NA	6,500	2.5	6,500
Silver (total)	7440-22-4	NA	6,500	0.50	6,500
Styrene	100-42-5	NA	260,000	0.0050	260,000
Tertiary butyl alcohol (TBA)	75-65-0	NA	23,000	0.10	23,000
1,2,4,5-Tetrachlorobenzene	95-94-3	NA	270	0.17	270
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	NA	0.00081	0.0000010	0.00081[6]
1,1,2,2-Tetrachloroethane	79-34-5	18	26,000	0.0050	18

Tetrachloroethene (PCE) (Tetrachloroethylene)	**127-18-4**	**1,700**	**7,800**	**0.0050**	**1,700**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**NA**	**27,000**	**0.17**	**27,000**
Toluene	**108-88-3**	**NA**	**100,000**	**0.0050**	**100,000**
Toxaphene	**8001-35-2**	**2.3**	**NA**	**0.17**	**2.3**
1,2,4-Trichlorobenzene	**120-82-1**	**NA**	**9,100**	**0.0050**	**9,100**
1,1,1-Trichloroethane	**71-55-6**	**NA**	**2,600,000**	**0.0050**	**NA[1]**
1,1,2-Trichloroethane	**79-00-5**	**64**	**5,200**	**0.0050**	**64**
Trichloroethene (TCE) (Trichloroethylene)	**79-01-6**	**79**	**650**	**0.0050**	**79**
Trichlorofluoromethane (Freon 11)	**75-69-4**	**NA**	**390,000**	**0.0050**	**390,000**
2,4,5-Trichlorophenol	**95-95-4**	**NA**	**91,000**	**0.20**	**91,000**
2,4,6-Trichlorophenol	**88-06-2**	**230**	**910**	**0.20**	**230**
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	**76-13-1**	**NA**	**NA**	**0.0050**	**NA**
1,2,4-Trimethylbenzene	**95-63-6**	**NA**	**13,000**	**0.076**	**13,000**
Vanadium (total)	**7440-62-2**	**NA**	**6,500**	**2.5**	**6,500**
Vinyl chloride	**75-01-4**	**5.0**	**3,900**	**0.0050**	**5.0**
Xylenes (total)	**1330-20-7**	**NA**	**190,000**	**0.0050**	**190,000**
Zinc (total)	**7440-66-6**	**NA**	**390,000**	**1.0**	**390,000**

NA – Not applicable because appropriate toxicological information is not available

NA[1] – Standard not applicable because calculated health-based criterion exceeds one million mg/kg

[2] Standard is based on natural background

[3] Special calculation for EPH– see N.J.A.C. 7:26D Appendix 2

[4] Sample-specific calculation using EPH calculator – see N.J.A.C. 7:26D Appendix 2

[5] Standard based on the Adult Lead Model (ALM)

[6] This standard is used for comparison to site soil data that have been converted to sample-specific TCDD-TEQ values through application of the Toxicity Equivalence Factor Methodology (USEPA 2010) and using the WHO 2005 Mammalian Toxic Equivalency Factors (TEFs)

[7] Although n-Hexane does not have a specific reporting limit, quantification is required to be less than the applicable remediation standard

Table 3 – Soil Remediation Standards for the Inhalation Exposure Pathway – Residential (mg/kg) (All numeric values are rounded to two significant figures)

Contaminant	CAS No.	Carcinogenic Inhalation Human Health-based Criterion	Noncarcinogenic Inhalation Human Health-based Criterion	Soil Saturation Concentration	Reporting Limit	Soil Remediation Standard Inhalation Residential
Acenaphthene	83-32-9	NA[1]	NA[1]	40	0.17	NA[1]
Acetone (2-Propanone)	67-64-1	NA[1]	NA[1]	160,000	0.010	NA[1]
Acetophenone	98-86-2	NA[1]	NA[1]	1,600	0.33	NA[1]
Aldrin	309-00-2	NA[1]	NA[1]	2.8	0.0017	NA[1]
Aluminum (total)	7429-90-5	NA[1]	NA[2]	NA	20	NA[2]
Anthracene	120-12-7	NA[1]	NA[1]	1.4	0.17	NA[1]
Antimony (total)	7440-36-0	NA[1]	NA[1]	NA	1.0	NA[1]
Arsenic (total)	7440-38-2	1,100	NA[1]	NA	0.50	1,100
Atrazine	1912-24-9	NA[1]	NA[1]	21	0.33	NA[1]
Barium (total)	7440-39-3	NA[1]	870,000	NA	5.0	870,000
Benzaldehyde	100-52-7	NA[1]	NA[1]	1,200	0.33	NA[1]
Benzene	71-43-2	2.2	190	850	0.0050	2.2
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	78,000[4]	NA[1]	3.3	0.17	78,000[4]
Benzo(a)pyrene	50-32-8	7,800[4]	3,500[4]	1.9	0.17	3,500[4]
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	78,000[4]	NA[1]	1.8	0.17	78,000[4]
Benzo(k)fluoranthene	207-08-9	780,000[4]	NA[1]	0.94	0.17	780,000[4]
Beryllium	7440-41-7	2,000	35,000	NA	0.50	2,000
1,1'-Biphenyl	92-52-4	NA[1]	NA[1]	78	0.17	NA[1]
Bis(2-chloroethoxy)methane	111-91-1	NA[1]	NA[1]	1,400	0.17	NA[1]
Bis(2-chloroethyl)ether	111-44-4	NA[1]	NA[1]	3,700	0.33	NA[1]
Bis(2-ethylhexyl)phthalate	117-81-7	NA[1]	NA[1]	65	0.17	NA[1]
Bromodichloromethane (Dichlorobromomethane)	75-27-4	NA[1]	NA[1]	690	0.0050	NA[1]

Bromoform	**75-25-2**	**NA[1]**	**NA[1]**	**680**	**0.0050**	**NA[1]**
Bromomethane (Methyl bromide)	**74-83-9**	**NA[1]**	**18**	**3,300**	**0.0050**	**18**
2-Butanone (Methyl ethyl ketone) (MEK)	**78-93-3**	**NA[1]**	**NA[2,3]**	**36,000**	**0.010**	**NA[2,3]**
Butylbenzyl phthalate	**85-68-7**	**NA[1]**	**NA[1]**	**39**	**0.17**	**NA[1]**
Cadmium	**7440-43-9**	**2,600**	**17,000**	**NA**	**0.50**	**2,600**
Caprolactam	**105-60-2**	**NA[1]**	**290**	**160,000**	**0.33**	**290**
Carbon disulfide	**75-15-0**	**NA[1]**	**NA[2,3]**	**580**	**0.0050**	**NA[2,3]**
Carbon tetrachloride	**56-23-5**	**1.4**	**NA[2,3]**	**300**	**0.0050**	**1.4**
Chlordane (alpha and gamma forms summed)	**57-74-9**	**NA[1]**	**NA[2,3]**	**7.6**	**0.0017**	**NA[2,3]**
4-Chloroaniline	**106-47-8**	**NA[1]**	**NA[1]**	**1,500**	**0.17**	**NA[1]**
Chlorobenzene	**108-90-7**	**NA[1]**	**NA[2,3]**	**320**	**0.0050**	**NA[2,3]**
Chloroethane (Ethyl chloride)	**75-00-3**	**NA[1]**	**NA[2,3]**	**1,700**	**0.0050**	**NA[2,3]**
Chloroform	**67-66-3**	**NA[1]**	**590**	**1,900**	**0.0050**	**590**
Chloromethane (Methyl chloride)	**74-87-3**	**NA[1]**	**270**	**1,200**	**0.0050**	**270**
2-Chloronaphthalene	**91-58-7**	**NA[1]**	**NA[1]**	**60**	**0.17**	**NA[1]**
2-Chlorophenol (o-Chlorophenol)	**95-57-8**	**NA[1]**	**NA[1]**	**11,000**	**0.17**	**NA[1]**
Chrysene	**218-01-9**	**NA[2,3]**	**NA[1]**	**0.72**	**0.17**	**NA[2,3]**
Cobalt (total)	**7440-48-4**	**520**	**10,000**	**NA**	**0.50**	**520**
Copper (total)	**7440-50-8**	**NA[1]**	**NA[1]**	**NA**	**1.0**	**NA[1]**
Cyanide	**57-12-5**	**NA[1]**	**NA[2]**	**NA**	**0.50**	**NA[2]**
Cyclohexane	**110-82-7**	**NA[1]**	**NA[2,3]**	**65**	**0.0050**	**NA[2,3]**
4,4'-DDD (p,p'-TDE)	**72-54-8**	**NA[1]**	**NA[1]**	**21**	**0.0033**	**NA[1]**
4,4'-DDE (p,p'-DDX)	**72-55-9**	**NA[1]**	**NA[1]**	**9.4**	**0.0033**	**NA[1]**
4,4'-DDT	**50-29-3**	**NA[1]**	**NA[1]**	**1.9**	**0.0033**	**NA[1]**
Dibenz(a,h)anthracene	**53-70-3**	**7,800[4]**	**NA[1]**	**9.5**	**0.17**	**7,800[4]**
Dibromochloromethane (Chlorodibromomethane)	**124-48-1**	**NA[1]**	**NA[1]**	**600**	**0.0050**	**NA[1]**
1,2-Dibromo-3-chloropropane	**96-12-8**	**0.026**	**11**	**470**	**0.0050**	**0.026**
1,2-Dibromoethane (Ethylene dibromide)	**106-93-4**	**0.085**	**170**	**920**	**0.005**	**0.085**
1,2-Dichlorobenzene (o-Dichlorobenzene)	**95-50-1**	**NA[1]**	**NA[2,3]**	**140**	**0.005**	**NA[2,3]**
1,3-Dichlorobenzene (m-Dichlorobenzene)	**541-73-1**	**NA[1]**	**NA[1]**	**110**	**0.005**	**NA[1]**
1,4-Dichlorobenzene (p-Dichlorobenzene)	**106-46-7**	**NA[1]**	**NA[2,3]**	**74**	**0.005**	**NA[2,3]**
3,3'-Dichlorobenzidine	**91-94-1**	**NA[1]**	**NA[1]**	**20**	**0.33**	**NA[1]**

Dichlorodifluoromethane (Freon 12)	**75-71-8**	**NA[1]**	**NA[1]**	**540**	**0.0050**	**NA[1]**
1,1-Dichloroethane	**75-34-3**	**NA[1]**	**NA[1]**	**1,200**	**0.0050**	**NA[1]**
1,2-Dichloroethane	**107-06-2**	**NA[1]**	**71**	**2,000**	**0.0050**	**71**
1,1-Dichloroethene (1,1-Dichloroethylene)	**75-35-4**	**NA[1]**	**52**	**830**	**0.0050**	**52**
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	**156-59-2**	**NA[1]**	**NA[1]**	**1,600**	**0.0050**	**NA[1]**
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	**156-60-5**	**NA[1]**	**NA[1]**	**1,300**	**0.0050**	**NA[1]**
2,4-Dichlorophenol	**120-83-2**	**NA[1]**	**NA[1]**	**2,600**	**0.17**	**NA[1]**
1,2-Dichloropropane	**78-87-5**	**5.7**	**31**	**810**	**0.0050**	**5.7**
1,3-Dichloropropene (total)	**542-75-6**	**4.8**	**140**	**880**	**0.0050**	**4.8**
Dieldrin	**60-57-1**	**NA[1]**	**NA[1]**	**7.9**	**0.0033**	**NA[1]**
Diethylphthalate	**84-66-2**	**NA[1]**	**NA[1]**	**390**	**0.17**	**NA[1]**
2,4-Dimethylphenol	**105-67-9**	**NA[1]**	**NA[1]**	**8,900**	**0.17**	**NA[1]**
Di-n-butyl phthalate	**84-74-2**	**NA[1]**	**NA[1]**	**28**	**0.17**	**NA[1]**
2,4-Dinitrophenol	**51-28-5**	**NA[1]**	**NA[1]**	**430**	**0.33**	**NA[1]**
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	**25321-14-6**	**NA[1]**	**NA[1]**	**360**	**0.17**	**NA[1]**
Di-n-octyl phthalate	**117-84-0**	**NA[1]**	**NA[1]**	**6.2**	**0.33**	**NA[1]**
1,4-Dioxane	**123-91-1**	**45**	**2,500**	**160,000**	**0.067**	**45**
Endosulfan I and Endosulfan II (alpha and beta) (summed)	**115-29-7**	**NA[1]**	**NA[1]**	**4.4**	**0.0033**	**NA[1]**
Endrin	**72-20-8**	**NA[1]**	**NA[1]**	**10**	**0.0033**	**NA[1]**
Ethylbenzene	**100-41-4**	**10**	**NA[2,3]**	**180**	**0.0050**	**10**
Extractable Petroleum Hydrocarbons (Category 1)	**various**	**NA[1]**	**NA[1]**	**NA**	**80**	**NA[1]**
Extractable Petroleum Hydrocarbons (Category 2)	**various**	**NA[1]**	**NA[1]**	**NA**	**80**	**NA[1]**
Fluoranthene	**206-44-0**	**NA[1]**	**NA[1]**	**29**	**0.33**	**NA[1]**
Fluorene	**86-73-7**	**NA[1]**	**NA[1]**	**31**	**0.17**	**NA**
alpha-HCH (alpha-BHC)	**319-84-6**	**NA[1]**	**NA[1]**	**12**	**0.0017**	**NA[1]**
beta-HCH (beta-BHC)	**319-85-7**	**NA[1]**	**NA[1]**	**1.4**	**0.0017**	**NA[1]**
Heptachlor	**76-44-8**	**NA[1]**	**NA[1]**	**15**	**0.0017**	**NA[1]**
Heptachlor epoxide	**1024-57-3**	**NA[1]**	**NA[1]**	**4.1**	**0.0017**	**NA[1]**
Hexachlorobenzene	**118-74-1**	**NA[1]**	**NA[1]**	**0.078**	**0.17**	**NA[1]**
Hexachloro-1,3-butadiene	**87-68-3**	**NA[1]**	**NA[1]**	**6.1**	**0.17**	**NA[1]**
Hexachlorocyclopentadiene	**77-47-4**	**NA[1]**	**2.7**	**5.6**	**0.33**	**2.7**
Hexachloroethane	**67-72-1**	**NA[1]**	**NA[2,3]**	**28**	**0.17**	**NA[2,3]**
n-Hexane	**110-54-3**	**NA[1]**	**NA[2,3]**	**88**	**NA**	**NA[2,3]**
2-Hexanone	**591-78-6**	**NA[1]**	**1,000**	**3,200**	**0.010**	**1,000**

Indeno(1,2,3-cd)pyrene	**193-39-5**	**78,000[4]**	**NA[1]**	**0.74**	**0.17**	**78,000[4]**
Isophorone	**78-59-1**	**NA[1]**	**NA[2,3]**	**3,400**	**0.17**	**NA[2,3]**
Isopropylbenzene	**98-82-8**	**NA[1]**	**NA[2,3]**	**98**	**0.0050**	**NA[2,3]**
Lead (total)	**7439-92-1**	**NA[1]**	**NA[1]**	**NA**	**0.50**	**NA[1]**
Lindane (gamma-HCH) (gamma-BHC)	**58-89-9**	**NA[1]**	**NA[1]**	**42**	**0.0017**	**NA[1]**
Manganese (total)	**7439-96-5**	**NA[1]**	**87,000**	**NA**	**0.50**	**87,000**
Mercury (total)	**7439-97-6**	**NA[1]**	**520,000[4]**	**3.1**	**0.10**	**520,000[4]**
Methoxychlor	**72-43-5**	**NA[1]**	**NA[1]**	**5.4**	**0.017**	**NA[1]**
Methyl acetate	**79-20-9**	**NA[1]**	**NA[1]**	**39,000**	**0.0050**	**NA[1]**
Methylene chloride (Dichloromethane)	**75-09-2**	**1,400**	**NA[2,3]**	**2,800**	**0.0050**	**1,400**
2-Methylnaphthalene	**91-57-6**	**NA[1]**	**NA[1]**	**130**	**0.17**	**NA[1]**
4-Methyl-2-pentanone (MIBK)	**108-10-1**	**NA[1]**	**NA[2,3]**	**3,400**	**0.010**	**NA[2,3]**
2-Methylphenol (o-cresol)	**95-48-7**	**NA[1]**	**NA[1]**	**20,000**	**0.33**	**NA[1]**
4-Methylphenol (p-cresol)	**106-44-5**	**NA[1]**	**NA[1]**	**16,000**	**0.33**	**NA[1]**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**140**	**NA[2,3]**	**9,100**	**0.0050**	**140**
Naphthalene	**91-20-3**	**5.7**	**NA[2,3]**	**100**	**0.17**	**5.7**
Nickel (total)	**7440-02-0**	**20,000**	**24,000**	**NA**	**0.50**	**20,000**
4-Nitroaniline	**100-01-6**	**NA[1]**	**NA[2,3]**	**270**	**0.33**	**NA[2,3]**
Nitrobenzene	**98-95-3**	**7.5**	**1,000**	**1,300**	**0.17**	**7.5**
N-Nitrosodi-n-propylamine	**621-64-7**	**NA[1]**	**NA[1]**	**9,200**	**0.17**	**NA[1]**
N-Nitrosodiphenylamine	**86-30-6**	**NA[1]**	**NA[1]**	**190**	**0.17**	**NA[1]**
2,2'-oxybis(1-chloropropane)	**108-60-1**	**NA[1]**	**NA[1]**	**540**	**0.33**	**NA[1]**
Pentachlorophenol	**87-86-5**	**NA[1]**	**NA[1]**	**140**	**0.33**	**NA[1]**
Phenol	**108-95-2**	**NA[1]**	**39,000**	**44,000**	**0.33**	**39,000**
Polychlorinated biphenyls (PCBs)	**1336-36-3**	**NA[1]**	**NA[1]**	**110**	**0.030**	**NA[1]**
Pyrene	**129-00-0**	**NA[1]**	**NA[1]**	**15**	**0.17**	**NA[1]**
Selenium (total)	**7782-49-2**	**NA[1]**	**NA[1]**	**NA**	**2.5**	**NA[1]**
Silver (total)	**7440-22-4**	**NA[1]**	**NA[1]**	**NA**	**0.50**	**NA[1]**
Styrene	**100-42-5**	**NA[1]**	**NA[2,3]**	**330**	**0.0050**	**NA[2,3]**
Tertiary butyl alcohol (TBA)	**75-65-0**	**NA[1]**	**NA[1]**	**160,000**	**0.10**	**NA[1]**
1,2,4,5-Tetrachlorobenzene	**95-94-3**	**NA[1]**	**NA[1]**	**2.7**	**0.17**	**NA[1]**
2,3,7,8-Tetrachlorodibenzo-p-dioxin	**1746-01-6**	**NA[1]**	**NA[1]**	**0.10**	**0.0000010**	**NA[1]**
1,1,2,2-Tetrachloroethane	**79-34-5**	**NA[1]**	**NA[1]**	**980**	**0.0050**	**NA[1]**
Tetrachloroethene (PCE) (Tetrachloroethylene)	**127-18-4**	**47**	**NA[2,3]**	**89**	**0.0050**	**47**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**NA[1]**	**NA[1]**	**150**	**0.17**	**NA[1]**

Toluene	**108-88-3**	**NA[1]**	**NA[2,3]**	**340**	**0.0050**	**NA[2,3]**
Toxaphene	**8001-35-2**	**NA[1]**	**NA[1]**	**85**	**0.17**	**NA[1]**
1,2,4-Trichlorobenzene	**120-82-1**	**NA[1]**	**94**	**140**	**0.0050**	**94**
1,1,1-Trichloroethane	**71-55-6**	**NA[1]**	**NA[2,3]**	**420**	**0.0050**	**NA[2,3]**
1,1,2-Trichloroethane	**79-00-5**	**NA[1]**	**NA[1]**	**1,300**	**0.0050**	**NA[1]**
Trichloroethene (TCE) (Trichloroethylene)	**79-01-6**	**3.0**	**9.1**	**410**	**0.0050**	**3.0**
Trichlorofluoromethane (Freon 11)	**75-69-4**	**NA[1]**	**NA[1]**	**790**	**0.0050**	**NA[1]**
2,4,5-Trichlorophenol	**95-95-4**	**NA[1]**	**NA[1]**	**5,800**	**0.20**	**NA[1]**
2,4,6-Trichlorophenol	**88-06-2**	**NA[1]**	**NA[1]**	**1,700**	**0.20**	**NA[1]**
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	**76-13-1**	**NA[1]**	**NA[2,3]**	**530**	**0.0050**	**NA[2,3]**
1,2,4-Trimethylbenzene	**95-63-6**	**NA[1]**	**NA[2,3]**	**80**	**0.076**	**NA[2,3]**
Vanadium (total)	**7440-62-2**	**NA[1]**	**170,000**	**NA**	**2.5**	**170,000**
Vinyl chloride	**75-01-4**	**1.4**	**220**	**2,900**	**0.0050**	**1.4**
Xylenes (total)	**1330-20-7**	**NA[1]**	**NA[2,3]**	**100**	**0.0050**	**NA[2,3]**
Zinc (total)	**7440-66-6**	**NA[1]**	**NA[1]**	**NA**	**1.0**	**NA[1]**

NA – Not applicable because soil saturation concentrations do not exist for metals

NA[1] – Not applicable because appropriate toxicological information is not available

NA[2] – Standard not applicable because the calculated health-based criterion exceeds one million mg/kg

NA[3] – Standard not applicable because the calculated health-based criterion exceeds the soil saturation limit

[4] Exceeds soil saturation limit; however, health-based criterion based on particulate portion of the equation

Table 4 – Soil Remediation Standards for the Inhalation Exposure Pathway –

Nonresidential (mg/kg) (All numeric values are rounded to two significant figures)

Contaminant	CAS No.	Carcinogenic Inhalation Human Health-based Criterion	Noncarcinogenic Inhalation Human Health-based Criterion	Soil Saturation Concentration	Reporting Limit	Soil Remediation Standard Inhalation Nonresidential
Acenaphthene	83-32-9	NA[1]	NA[1]	40	0.17	NA[1]
Acetone (2-Propanone)	67-64-1	NA[1]	NA[1]	160,000	0.010	NA[1]
Acetophenone	98-86-2	NA[1]	NA[1]	1,600	0.33	NA[1]
Aldrin	309-00-2	NA[1]	NA[1]	2.8	0.0017	NA[1]
Aluminum (total)	7429-90-5	NA[1]	NA[2]	NA	20	NA[2]
Anthracene	120-12-7	NA[1]	NA[1]	1.4	0.17	NA[1]
Antimony (total)	7440-36-0	NA[1]	NA[1]	NA	1.0	NA[1]
Arsenic (total)	7440-38-2	5,200	NA[1]	NA	0.50	5,200
Atrazine	1912-24-9	NA[1]	NA[1]	21	0.33	NA[1]
Barium (total)	7440-39-3	NA[1]	NA[2]	NA	5.0	NA[2]
Benzaldehyde	100-52-7	NA[1]	NA[1]	1,200	0.33	NA[1]
Benzene	71-43-2	11	NA[2,3]	850	0.0050	11
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	370,000[4]	NA[1]	3.3	0.17	370,000[4]
Benzo(a)pyrene	50-32-8	37,000[4]	16,000[4]	1.9	0.17	16,000[4]
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	370,000[4]	NA[1]	1.8	0.17	370,000[4]
Benzo(k)fluoranthene	207-08-9	NA[2,3]	NA[1]	0.94	0.17	NA[2,3]
Beryllium	7440-41-7	9,300	160,000	NA	0.50	9,300
1,1'-Biphenyl	92-52-4	NA[1]	NA[1]	78	0.17	NA[1]
Bis(2-chloroethoxy)methane	111-91-1	NA[1]	NA[1]	1,400	0.17	NA[1]
Bis(2-chloroethyl)ether	111-44-4	NA[1]	NA[1]	3,700	0.33	NA[1]
Bis(2-ethylhexyl)phthalate	117-81-7	NA[1]	NA[1]	65	0.17	NA[1]
Bromodichloromethane (Dichlorobromomethane)	75-27-4	NA[1]	NA[1]	690	0.0050	NA[1]
Bromoform	75-25-2	NA[1]	NA[1]	680	0.0050	NA[1]
Bromomethane (Methyl bromide)	74-83-9	NA[1]	82	3,300	0.0050	82
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	NA[1]	NA[2,3]	36,000	0.010	NA[2,3]
Butylbenzyl phthalate	85-68-7	NA[1]	NA[1]	39	0.17	NA[1]
Cadmium	7440-43-9	12,000	80,000	NA	0.50	12,000
Caprolactam	105-60-2	NA[1]	1,300	160,000	0.33	1,300
Carbon disulfide	75-15-0	NA[1]	NA[2,3]	580	0.0050	NA[2,3]
Carbon tetrachloride	56-23-5	6.9	NA[2,3]	300	0.0050	6.9

Chlordane (alpha and gamma forms summed)	**57-74-9**	**NA[1]**	**NA[2,3]**	**7.6**	**0.0017**	**NA[2,3]**
4-Chloroaniline	**106-47-8**	**NA[1]**	**NA[1]**	**1,500**	**0.17**	**NA[1]**
Chlorobenzene	**108-90-7**	**NA[1]**	**NA[2,3]**	**320**	**0.0050**	**NA[2,3]**
Chloroethane (Ethyl chloride)	**75-00-3**	**NA[1]**	**NA[2,3]**	**1,700**	**0.0050**	**NA[2,3]**
Chloroform	**67-66-3**	**NA[1]**	**NA[2,3]**	**1,900**	**0.0050**	**NA[2,3]**
Chloromethane (Methyl chloride)	**74-87-3**	**NA[1]**	**1,200**	**1,200**	**0.0050**	**1,200**
2-Chloronaphthalene	**91-58-7**	**NA[1]**	**NA[1]**	**60**	**0.17**	**NA[1]**
2-Chlorophenol (o-Chlorophenol)	**95-57-8**	**NA[1]**	**NA[1]**	**11,000**	**0.17**	**NA[1]**
Chrysene	**218-01-9**	**NA[2,3]**	**NA[1]**	**0.72**	**0.17**	**NA[2,3]**
Cobalt (total)	**7440-48-4**	**2,500**	**48,000**	**NA**	**0.50**	**2,500**
Copper (total)	**7440-50-8**	**NA[1]**	**NA[1]**	**NA**	**1.0**	**NA[1]**
Cyanide	**57-12-5**	**NA[1]**	**NA[2]**	**NA**	**0.50**	**NA[2]**
Cyclohexane	**110-82-7**	**NA[1]**	**NA[2,3]**	**65**	**0.0050**	**NA[2,3]**
4,4'-DDD (p,p'-TDE)	**72-54-8**	**NA[1]**	**NA[1]**	**21**	**0.0033**	**NA[1]**
4,4'-DDE (p,p'-DDX)	**72-55-9**	**NA[1]**	**NA[1]**	**9.4**	**0.0033**	**NA[1]**
4,4'-DDT	**50-29-3**	**NA[1]**	**NA[1]**	**1.9**	**0.0033**	**NA[1]**
Dibenz(a,h)anthracene	**53-70-3**	**37,000[4]**	**NA[1]**	**9.5**	**0.17**	**37,000[4]**
Dibromochloromethane (Chlorodibromomethane)	**124-48-1**	**NA[1]**	**NA[1]**	**600**	**0.0050**	**NA[1]**
1,2-Dibromo-3-chloropropane	**96-12-8**	**0.12**	**52**	**470**	**0.0050**	**0.12**
1,2-Dibromoethane (Ethylene dibromide)	**106-93-4**	**0.41**	**780**	**920**	**0.0050**	**0.41**
1,2-Dichlorobenzene (o-Dichlorobenzene)	**95-50-1**	**NA[1]**	**NA[2,3]**	**140**	**0.0050**	**NA[2,3]**
1,3-Dichlorobenzene (m-Dichlorobenzene)	**541-73-1**	**NA[1]**	**NA[1]**	**110**	**0.0050**	**NA[1]**
1,4-Dichlorobenzene (p-Dichlorobenzene)	**106-46-7**	**NA[1]**	**NA[2,3]**	**74**	**0.0050**	**NA[2,3]**
3,3'-Dichlorobenzidine	**91-94-1**	**NA[1]**	**NA[1]**	**20**	**0.33**	**NA[1]**
Dichlorodifluoromethane (Freon 12)	**75-71-8**	**NA[1]**	**NA[1]**	**540**	**0.0050**	**NA[1]**
1,1-Dichloroethane	**75-34-3**	**NA[1]**	**NA[1]**	**1,200**	**0.0050**	**NA[1]**
1,2-Dichloroethane	**107-06-2**	**NA[1]**	**320**	**2,000**	**0.0050**	**320**
1,1-Dichloroethene (1,1-Dichloroethylene)	**75-35-4**	**NA[1]**	**240**	**830**	**0.0050**	**240**
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	**156-59-2**	**NA[1]**	**NA[1]**	**1,600**	**0.0050**	**NA[1]**
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	**156-60-5**	**NA[1]**	**NA[1]**	**1,300**	**0.0050**	**NA[1]**

2,4-Dichlorophenol	**120-83-2**	**NA[1]**	**NA[1]**	**2,600**	**0.17**	**NA[1]**
1,2-Dichloropropane	**78-87-5**	**27**	**140**	**810**	**0.0050**	**27**
1,3-Dichloropropene (total)	**542-75-6**	**23**	**650**	**880**	**0.0050**	**23**
Dieldrin	**60-57-1**	**NA[1]**	**NA[1]**	**7.9**	**0.0033**	**NA[1]**
Diethylphthalate	**84-66-2**	**NA[1]**	**NA[1]**	**390**	**0.17**	**NA[1]**
2,4-Dimethylphenol	**105-67-9**	**NA[1]**	**NA[1]**	**8,900**	**0.17**	**NA[1]**
Di-n-butyl phthalate	**84-74-2**	**NA[1]**	**NA[1]**	**28**	**0.17**	**NA[1]**
2,4-Dinitrophenol	**51-28-5**	**NA[1]**	**NA[1]**	**430**	**0.33**	**NA[1]**
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	**25321-14-6**	**NA[1]**	**NA[1]**	**360**	**0.17**	**NA[1]**
Di-n-octyl phthalate	**117-84-0**	**NA[1]**	**NA[1]**	**6.2**	**0.33**	**NA[1]**
1,4-Dioxane	**123-91-1**	**210**	**11,000**	**160,000**	**0.067**	**210**
Endosulfan I and Endosulfan II (alpha and beta) (summed)	**115-29-7**	**NA[1]**	**NA[1]**	**4.4**	**0.0033**	**NA[1]**
Endrin	**72-20-8**	**NA[1]**	**NA[1]**	**10**	**0.0033**	**NA[1]**
Ethylbenzene	**100-41-4**	**48**	**NA[2,3]**	**180**	**0.0050**	**48**
Extractable Petroleum Hydrocarbons (Category 1)	**various**	**NA[1]**	**NA[1]**	**NA**	**80**	**NA[1]**
Extractable Petroleum Hydrocarbons (Category 2)	**various**	**NA[1]**	**NA[1]**	**NA**	**80**	**NA[1]**
Fluoranthene	**206-44-0**	**NA[1]**	**NA[1]**	**29**	**0.33**	**NA[1]**
Fluorene	**86-73-7**	**NA[1]**	**NA[1]**	**31**	**0.17**	**NA[1]**
alpha-HCH (alpha-BHC)	**319-84-6**	**NA[1]**	**NA[1]**	**12**	**0.0017**	**NA[1]**
beta-HCH (beta-BHC)	**319-85-7**	**NA[1]**	**NA[1]**	**1.4**	**0.0017**	**NA[1]**
Heptachlor	**76-44-8**	**NA[1]**	**NA[1]**	**15**	**0.0017**	**NA[1]**
Heptachlor epoxide	**1024-57-3**	**NA[1]**	**NA[1]**	**4.1**	**0.0017**	**NA[1]**
Hexachlorobenzene	**118-74-1**	**NA[1]**	**NA[1]**	**0.078**	**0.17**	**NA[1]**
Hexachloro-1,3-butadiene	**87-68-3**	**NA[1]**	**NA[1]**	**6.1**	**0.17**	**NA[1]**
Hexachlorocyclopentadiene	**77-47-4**	**NA[1]**	**NA[2,3]**	**5.6**	**0.33**	**NA[2,3]**
Hexachloroethane	**67-72-1**	**NA[1]**	**NA[2,3]**	**28**	**0.17**	**NA[2,3]**
n-Hexane	**110-54-3**	**NA[1]**	**NA[2,3]**	**88**	**NA**	**NA[2,3]**
2-Hexanone	**591-78-6**	**NA[1]**	**NA[2,3]**	**3,200**	**0.010**	**NA[2,3]**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**370,000[4]**	**NA[1]**	**0.74**	**0.17**	**370,000[4]**
Isophorone	**78-59-1**	**NA[1]**	**NA[2,3]**	**3,400**	**0.17**	**NA[2,3]**
Isopropylbenzene	**98-82-8**	**NA[1]**	**NA[2,3]**	**98**	**0.0050**	**NA[2,3]**
Lead (total)	**7439-92-1**	**NA[1]**	**NA[1]**	**NA**	**0.50**	**NA[1]**
Lindane (gamma-HCH) (gamma-BHC)	**58-89-9**	**NA[1]**	**NA[1]**	**42**	**0.0017**	**NA[1]**
Manganese (total)	**7439-96-5**	**NA[1]**	**400,000**	**NA**	**0.50**	**400,000**
Mercury (total)	**7439-97-6**	**NA[1]**	**NA[2,3]**	**3.1**	**0.10**	**NA[2,3]**

Methoxychlor	**72-43-5**	**NA[1]**	**NA[1]**	**5.4**	**0.017**	**NA[1]**
Methyl acetate	**79-20-9**	**NA[1]**	**NA[1]**	**39,000**	**0.0050**	**NA[1]**
Methylene chloride (Dichloromethane)	**75-09-2**	**NA[2,3]**	**NA[2,3]**	**2,800**	**0.0050**	**NA[2,3]**
2-Methylnaphthalene	**91-57-6**	**NA[1]**	**NA[1]**	**130**	**0.17**	**NA[1]**
4-Methyl-2-pentanone (MIBK)	**108-10-1**	**NA[1]**	**NA[2,3]**	**3,400**	**0.010**	**NA[2,3]**
2-Methylphenol (o-cresol)	**95-48-7**	**NA[1]**	**NA[1]**	**20,000**	**0.33**	**NA[1]**
4-Methylphenol (p-cresol)	**106-44-5**	**NA[1]**	**NA[1]**	**16,000**	**0.33**	**NA[1]**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**650**	**NA[2,3]**	**9,100**	**0.0050**	**650**
Naphthalene	**91-20-3**	**27**	**NA[2,3]**	**100**	**0.17**	**27**
Nickel (total)	**7440-02-0**	**93,000**	**110,000**	**NA**	**0.50**	**93,000**
4-Nitroaniline	**100-01-6**	**NA[1]**	**NA[2,3]**	**270**	**0.33**	**NA[2,3]**
Nitrobenzene	**98-95-3**	**36**	**NA[2,3]**	**1,300**	**0.17**	**36**
N-Nitrosodi-n-propylamine	**621-64-7**	**NA[1]**	**NA[1]**	**9,200**	**0.17**	**NA[1]**
N-Nitrosodiphenylamine	**86-30-6**	**NA[1]**	**NA[1]**	**190**	**0.17**	**NA[1]**
2,2'-oxybis(1-chloropropane)	**108-60-1**	**NA[1]**	**NA[1]**	**540**	**0.33**	**NA[1]**
Pentachlorophenol	**87-86-5**	**NA[1]**	**NA[1]**	**140**	**0.33**	**NA[1]**
Phenol	**108-95-2**	**NA[1]**	**NA[2,3]**	**44,000**	**0.33**	**NA[2,3]**
Polychlorinated biphenyls (PCBs)	**1336-36-3**	**NA[1]**	**NA[1]**	**110**	**0.030**	**NA[1]**
Pyrene	**129-00-0**	**NA[1]**	**NA[1]**	**15**	**0.17**	**NA[1]**
Selenium (total)	**7782-49-2**	**NA[1]**	**NA[1]**	**NA**	**2.5**	**NA[1]**
Silver (total)	**7440-22-4**	**NA[1]**	**NA[1]**	**NA**	**0.50**	**NA[1]**
Styrene	**100-42-5**	**NA[1]**	**NA[2,3]**	**330**	**0.0050**	**NA[2,3]**
Tertiary butyl alcohol (TBA)	**75-65-0**	**NA[1]**	**NA[1]**	**160,000**	**0.10**	**NA[1]**
1,2,4,5-Tetrachlorobenzene	**95-94-3**	**NA[1]**	**NA[1]**	**2.7**	**0.17**	**NA[1]**
2,3,7,8-Tetrachlorodibenzo-p-dioxin	**1746-01-6**	**NA[1]**	**NA[1]**	**0.10**	**0.0000010**	**NA[1]**
1,1,2,2-Tetrachloroethane	**79-34-5**	**NA[1]**	**NA[1]**	**980**	**0.0050**	**NA[1]**
Tetrachloroethene (PCE) (Tetrachloroethylene)	**127-18-4**	**NA[2,3]**	**NA[2,3]**	**89**	**0.0050**	**NA[2,3]**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**NA[1]**	**NA[1]**	**150**	**0.17**	**NA[1]**
Toluene	**108-88-3**	**NA[1]**	**NA[2,3]**	**340**	**0.0050**	**NA[2,3]**
Toxaphene	**8001-35-2**	**NA[1]**	**NA[1]**	**85**	**0.17**	**NA[1]**
1,2,4-Trichlorobenzene	**120-82-1**	**NA[1]**	**NA[2,3]**	**140**	**0.0050**	**NA[2,3]**
1,1,1-Trichloroethane	**71-55-6**	**NA[1]**	**NA[2,3]**	**420**	**0.0050**	**NA[2,3]**
1,1,2-Trichloroethane	**79-00-5**	**NA[1]**	**NA[1]**	**1,300**	**0.0050**	**NA[1]**
Trichloroethene (TCE) (Trichloroethylene)	**79-01-6**	**14**	**42**	**410**	**0.0050**	**14**

Trichlorofluoromethane (Freon 11)	**75-69-4**	**NA[1]**	**NA[1]**	**790**	**0.0050**	**NA[1]**
2,4,5-Trichlorophenol	**95-95-4**	**NA[1]**	**NA[1]**	**5,800**	**0.20**	**NA[1]**
2,4,6-Trichlorophenol	**88-06-2**	**NA[1]**	**NA[1]**	**1,700**	**0.20**	**NA[1]**
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	**76-13-1**	**NA[1]**	**NA[2,3]**	**530**	**0.0050**	**NA[2,3]**
1,2,4-Trimethylbenzene	**95-63-6**	**NA[1]**	**NA[2,3]**	**80**	**0.076**	**NA[2,3]**
Vanadium (total)	**7440-62-2**	**NA[1]**	**800,000**	**NA**	**2.5**	**800,000**
Vinyl chloride	**75-01-4**	**6.4**	**1,000**	**2,900**	**0.0050**	**6.4**
Xylenes (total)	**1330-20-7**	**NA[1]**	**NA[2,3]**	**100**	**0.0050**	**NA[2,3]**
Zinc (total)	**7440-66-6**	**NA[1]**	**NA[1]**	**NA**	**1.0**	**NA[1]**

NA[1] Not applicable because appropriate toxicological information is not available

NA[2] Standard not applicable because the calculated health-based criterion exceeds one million mg/kg

NA[3] Standard not applicable because the calculated health-based criterion exceeds the soil saturation limit

[4] Exceeds soil saturation limit; however, health-based criterion based on particulate portion of the equation

Table 5 – Soil Remediation Standards for the Migration to Ground Water Exposure Pathway (mg/kg) (All ground water remediation standards are rounded to one significant figure[A]; all other numeric values are rounded to two significant figures)

Contaminant	CAS No.	Ground Water Remediation Standard (µg/L)	Migration to Ground Water Soil Criterion (mg/kg)	Soil Saturation Limit (mg/kg)	Reporting Limit (mg/kg)	Migration to Ground Water Soil Remediation Standard (mg/kg)
Acenaphthene	**83-32-9**	**400**	**82**	**40**	**0.17**	**NA[1]**
Acetone (2-Propanone)	**67-64-1**	**6,000**	**19**	**160,000**	**0.010**	**19**

Acetophenone	**98-86-2**	**700**	**3.6**	**1,600**	**0.33**	**3.6**
Aldrin	**309-00-2**	**0.04**	**0.13**	**2.8**	**0.0017**	**0.13**
Aluminum (total)	**7429-90-5**	**NA[2]**	**NA[2]**	**NA[3]**	**20**	**NA[2]**
Anthracene	**120-12-7**	**2,000**	**1,300**	**1.4**	**0.17**	**NA[1]**
Antimony (total)	**7440-36-0**	**6**	**5.4**	**NA[3]**	**1.0**	**5.4**
Arsenic (total)	**7440-38-2**	**3**	**1.6**	**NA[3]**	**0.50**	**19[4]**
Atrazine	**1912-24-9**	**3**	**0.036**	**21**	**0.33**	**0.33[5]**
Barium (total)	**7440-39-3**	**6,000**	**2,100**	**NA[3]**	**5.0**	**2,100**
Benzaldehyde	**100-52-7**	**NA[6]**	**NA[6]**	**1,200**	**0.33**	**NA[6]**
Benzene	**71-43-2**	**1**	**0.0094**	**850**	**0.0050**	**0.0094**
Benzo(a)anthracene (1,2-Benzanthracene)	**56-55-3**	**0.1**	**0.71**	**3.3**	**0.17**	**0.71**
Benzo(a)pyrene	**50-32-8**	**0.1**	**2.3**	**1.9**	**0.17**	**NA[1]**
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	**205-99-2**	**0.2**	**4.8**	**1.8**	**0.17**	**NA[1]**
Benzo(k)fluoranthene	**207-08-9**	**0.5**	**12**	**0.94**	**0.17**	**NA[1]**
Beryllium	**7440-41-7**	**1**	**0.70**	**NA[3]**	**0.50**	**0.70**
1,1'-Biphenyl	**92-52-4**	**400**	**83**	**72**	**0.17**	**NA[1]**
Bis(2-chloroethoxy)methane	**111-91-1**	**NA[6]**	**NA[6]**	**1,400**	**0.17**	**NA[6]**
Bis(2-chloroethyl)ether	**111-44-4**	**7**	**0.030**	**3,700**	**0.33**	**0.33[5]**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**3**	**14**	**65**	**0.17**	**14**
Bromodichloromethane (Dichlorobromomethane)	**75-27-4**	**1**	**0.0045**	**690**	**0.0050**	**0.0050[5]**
Bromoform	**75-25-2**	**4**	**0.018**	**680**	**0.0050**	**0.018**
Bromomethane (Methyl bromide)	**74-83-9**	**10**	**0.043**	**3,300**	**0.0050**	**0.043**
2-Butanone (Methyl ethyl ketone) (MEK)	**78-93-3**	**300**	**0.98**	**36,000**	**0.010**	**0.98**
Butylbenzyl phthalate	**85-68-7**	**100**	**29**	**39**	**0.17**	**29**
Cadmium	**7440-43-9**	**4**	**1.9**	**NA[3]**	**0.50**	**1.9**
Caprolactam	**105-60-2**	**4,000**	**16**	**160,000**	**0.33**	**16**
Carbon disulfide	**75-15-0**	**700**	**3.7**	**580**	**0.0050**	**3.7**
Carbon tetrachloride	**56-23-5**	**1**	**0.0075**	**300**	**0.0050**	**0.0075**
Chlordane (alpha and gamma forms summed)	**57-74-9**	**0.5**	**1.4**	**7.6**	**0.0017**	**1.4**
4-Chloroaniline	**106-47-8**	**30**	**0.23**	**1,500**	**0.17**	**0.23**
Chlorobenzene	**108-90-7**	**50**	**0.64**	**320**	**0.0050**	**0.64**
Chloroethane (Ethyl chloride)	**75-00-3**	**NA[6]**	**NA[6]**	**1,700**	**0.0050**	**NA[6]**
Chloroform	**67-66-3**	**70**	**0.33**	**1,900**	**0.0050**	**0.33**

Chloromethane (Methyl chloride)	**74-87-3**	**NA[6]**	**NA[6]**	**1,200**	**0.0050**	**NA[6]**
2-Chloronaphthalene	**91-58-7**	**600**	**61**	**60**	**0.17**	**NA[1]**
2-Chlorophenol (o-Chlorophenol)	**95-57-8**	**40**	**0.76**	**11,000**	**0.17**	**0.76**
Chrysene	**218-01-9**	**5**	**36**	**0.72**	**0.17**	**NA[1]**
Cobalt (total)	**7440-48-4**	**100**	**90**	**NA[3]**	**0.50**	**90**
Copper (total)	**7440-50-8**	**1,300**	**910**	**NA[3]**	**1.0**	**910**
Cyanide	**57-12-5**	**100**	**20**	**NA[3]**	**0.50**	**20**
Cyclohexane	**110-82-7**	**NA[6]**	**NA[6]**	**65**	**0.0050**	**NA[6]**
4,4'-DDD (p,p'-TDE)	**72-54-8**	**0.1**	**0.47**	**21**	**0.0033**	**0.47**
4,4'-DDE (p,p'-DDX)	**72-55-9**	**0.1**	**0.47**	**9.4**	**0.0033**	**0.47**
4,4'-DDT	**50-29-3**	**0.1**	**0.67**	**1.9**	**0.0033**	**0.67**
Dibenz(a,h)anthracene	**53-70-3**	**0.3**	**23**	**9.5**	**0.17**	**NA[1]**
Dibromochloromethane (Chlorodibromomethane)	**124-48-1**	**1**	**0.0044**	**600**	**0.0050**	**0.0050[5]**
1,2-Dibromo-3-chloropropane	**96-12-8**	**0.02**	**0.00015**	**470**	**0.0050**	**0.0050[5]**
1,2-Dibromoethane (Ethylene dibromide)	**106-93-4**	**0.03**	**0.00014**	**920**	**0.0050**	**0.0050[5]**
1,2-Dichlorobenzene (o-Dichlorobenzene)	**95-50-1**	**600**	**11**	**140**	**0.0050**	**11**
1,3-Dichlorobenzene (m-Dichlorobenzene)	**541-73-1**	**600**	**11**	**110**	**0.0050**	**11**
1,4-Dichlorobenzene (p-Dichlorobenzene)	**106-46-7**	**75**	**1.4**	**74**	**0.0050**	**1.4**
3,3'-Dichlorobenzidine	**91-94-1**	**30**	**3.9**	**20**	**0.33**	**3.9**
Dichlorodifluoromethane (Freon 12)	**75-71-8**	**1,000**	**38**	**540**	**0.0050**	**38**
1,1-Dichloroethane	**75-34-3**	**50**	**0.24**	**1,200**	**0.0050**	**0.24**
1,2-Dichloroethane	**107-06-2**	**2**	**0.0095**	**2,000**	**0.0050**	**0.0095**
1,1-Dichloroethene (1,1-Dichloroethylene)	**75-35-4**	**1**	**0.0069**	**830**	**0.0050**	**0.0069**
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	**156-59-2**	**70**	**0.35**	**1,600**	**0.0050**	**0.35**
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	**156-60-5**	**100**	**0.56**	**1,100**	**0.0050**	**0.56**
2,4-Dichlorophenol	**120-83-2**	**20**	**0.19**	**2,100**	**0.17**	**0.19**
1,2-Dichloropropane	**78-87-5**	**1**	**0.0058**	**810**	**0.0050**	**0.0058**
1,3-Dichloropropene (total)	**542-75-6**	**1**	**0.0063**	**880**	**0.0050**	**0.0063**
Dieldrin	**60-57-1**	**0.03**	**0.024**	**7.9**	**0.0033**	**0.024**

Diethylphthalate	**84-66-2**	**6,000**	**44**	**390**	**0.17**	**44**
2,4-Dimethylphenol	**105-67-9**	**100**	**2.3**	**8,900**	**0.17**	**2.3**
Di-n-butyl phthalate	**84-74-2**	**700**	**35**	**28**	**0.17**	**NA[1]**
2,4-Dinitrophenol	**51-28-5**	**40**	**0.12**	**430**	**0.33**	**0.33[5]**
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	**25321-14-6**	**10**	**0.27**	**360**	**0.17**	**0.27**
Di-n-octyl phthalate	**117-84-0**	**100**	**560**	**6.2**	**0.33**	**NA[1]**
1,4-Dioxane	**123-91-1**	**0.4**	**0.0013**	**160,000**	**0.067**	**0.067[5]**
Endosulfan I and Endosulfan II (alpha and beta) (summed)	**115-29-7**	**40**	**11**	**4.4**	**0.0033**	**NA[1]**
Endrin	**72-20-8**	**2**	**1.6**	**10**	**0.0033**	**1.6**
Ethylbenzene	**100-41-4**	**700**	**15**	**180**	**0.0050**	**15**
Extractable Petroleum Hydrocarbons (Category 1)	**various**	**NA[6]**	**NA[6]**	**NA[3]**	**80**	**NA[6]**
Extractable Petroleum Hydrocarbons (Category 2)	**various**	**NA[6]**	**NA[6]**	**NA[3]**	**80**	**NA[6]**
Fluoranthene	**206-44-0**	**300**	**670**	**29**	**0.33**	**NA[1]**
Fluorene	**86-73-7**	**300**	**110**	**31**	**0.17**	**NA[1]**
alpha-HCH (alpha-BHC)	**319-84-6**	**0.02**	**0.0023**	**12**	**0.0017**	**0.0023**
beta-HCH (beta-BHC)	**319-85-7**	**0.04**	**0.0046**	**1.4**	**0.0017**	**0.0046**
Heptachlor	**76-44-8**	**0.05**	**0.083**	**15**	**0.0017**	**0.083**
Heptachlor epoxide	**1024-57-3**	**0.2**	**0.081**	**4.1**	**0.0017**	**0.081**
Hexachlorobenzene	**118-74-1**	**0.02**	**0.0050**	**0.078**	**0.17**	**0.17[5]**
Hexachloro-1,3-butadiene	**87-68-3**	**1**	**0.038**	**6.1**	**0.17**	**0.17[5]**
Hexachlorocyclopentadiene	**77-47-4**	**40**	**2.5**	**5.6**	**0.33**	**2.5**
Hexachloroethane	**67-72-1**	**7**	**0.079**	**28**	**0.17**	**0.17[5]**
n-Hexane	**110-54-3**	**30**	**5.5**	**88**	**-**	**5.5**
2-Hexanone	**591-78-6**	**40**	**0.15**	**3,200**	**0.010**	**0.15**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**0.2**	**16**	**0.086**	**0.17**	**NA[1]**
Isophorone	**78-59-1**	**40**	**0.23**	**3,400**	**0.17**	**0.23**
Isopropylbenzene	**98-82-8**	**700**	**22**	**98**	**0.0050**	**22**
Lead (total)	**7439-92-1**	**5**	**90**	**NA[3]**	**0.50**	**90**
Lindane (gamma-HCH) (gamma-BHC)	**58-89-9**	**0.03**	**0.0035**	**42**	**0.0017**	**0.0035**
Manganese (total)	**7439-96-5**	**NA[2]**	**NA[2]**	**NA[3]**	**0.50**	**NA[2]**
Mercury (total)	**7439-97-6**	**2**	**0.014**	**NA[3]**	**0.10**	**0.10[5]**
Methoxychlor	**72-43-5**	**40**	**43**	**5.4**	**0.017**	**NA[1]**
Methyl acetate	**79-20-9**	**7,000**	**22**	**39,000**	**0.0050**	**22**
Methylene chloride (Dichloromethane)	**75-09-2**	**3**	**0.013**	**2,800**	**0.0050**	**0.013**

2-Methylnaphthalene	91-57-6	30	3.1	130	0.17	3.1
4-Methyl-2-pentanone (MIBK)	108-10-1	NA[6]	NA[6]	3,400	0.010	NA[6]
2-Methylphenol (o-cresol)	95-48-7	50	0.77	20,000	0.33	0.77
4-Methylphenol (p-cresol)	106-44-5	50	0.75	16,000	0.33	0.75
Methyl tert-butyl ether (MTBE)	1634-04-4	70	0.25	9,100	0.0050	0.25
Naphthalene	91-20-3	300	19	100	0.17	19
Nickel (total)	7440-02-0	100	48	NA[3]	0.50	48
4-Nitroaniline	100-01-6	NA[6]	NA[6]	270	0.33	NA[6]
Nitrobenzene	98-95-3	6	0.073	1,300	0.17	0.17[5]
N-Nitrosodi-n-propylamine	621-64-7	10	0.14	9,200	0.17	0.17[5]
N-Nitrosodiphenylamine	86-30-6	10	1.1	190	0.17	1.1
2,2'-oxybis(1-chloropropane)	108-60-1	300	1.9	540	0.33	1.9
Pentachlorophenol	87-86-5	0.3	0.062	140	0.33	0.33[5]
Phenol	108-95-2	2,000	21	44,000	0.33	21
Polychlorinated biphenyls (PCBs)	1336-36-3	0.5	1.6	110	0.030	1.6
Pyrene	129-00-0	200	440	15	0.17	NA[1]
Selenium (total)	7782-49-2	40	11	NA[3]	2.5	11
Silver (total)	7440-22-4	40	0.33	NA[3]	0.50	0.50[5]
Styrene	100-42-5	100	2.1	330	0.0050	2.1
Tertiary butyl alcohol (TBA)	75-65-0	100	0.32	160,000	0.10	0.32
1,2,4,5-Tetrachlorobenzene	95-94-3	NA[6]	NA[6]	2.7	0.17	NA[6]
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	0.00001	0.00010	0.10	0.0000010	0.00010[7]
1,1,2,2-Tetrachloroethane	79-34-5	1	0.0069	980	0.0050	0.0069
Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4	1	0.0086	89	0.0050	0.0086
2,3,4,6-Tetrachlorophenol	58-90-2	200	26	140	0.17	26
Toluene	108-88-3	600	7.8	340	0.0050	7.8
Toxaphene	8001-35-2	2	6.2	110	0.17	6.2
1,2,4-Trichlorobenzene	120-82-1	9	0.52	140	0.0050	0.52
1,1,1-Trichloroethane	71-55-6	30	0.20	420	0.0050	0.20
1,1,2-Trichloroethane	79-00-5	3	0.017	1,300	0.0050	0.017
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	1	0.0065	410	0.0050	0.0065
Trichlorofluoromethane (Freon 11)	75-69-4	2,000	29	790	0.0050	29
2,4,5-Trichlorophenol	95-95-4	700	68	5,800	0.20	68
2,4,6-Trichlorophenol	88-06-2	20	0.86	1,700	0.20	0.86

1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	**76-13-1**	**NA[6]**	**NA[6]**	**530**	**0.0050**	**NA[6]**
1,2,4-Trimethylbenzene	**95-63-6**	**NA[6]**	**NA[6]**	**80**	**0.076**	**NA[6]**
Vanadium (total)	**7440-62-2**	**NA[6]**	**NA[6]**	**NA[3]**	**2.5**	**NA[6]**
Vinyl chloride	**75-01-4**	**1**	**0.0067**	**2,900**	**0.0050**	**0.0067**
Xylenes (total)	**1330-20-7**	**1,000**	**19**	**100**	**0.0050**	**19**
Zinc (total)	**7440-66-6**	**2,000**	**930**	**NA[3]**	**1.0**	**930**

[A] The ground water remediation standards are listed using one significant figure to be consistent with the Ground Water Quality Standards, N.J.A.C. 7:9C

NA – Not applicable

[1] Standard not applicable because the calculated health-based criterion exceeds the soil saturation limit

[2] Standard not applicable because ground water remediation standard is a secondary standard

[3] Not applicable because soil saturation concentrations do not exist for metals and a soil saturation concentration for EPH has not been determined

[4] Standard is based on natural background

[5] Standard set to reporting limit

[6] Standard not applicable because a ground water remediation standard does not exist

[7] This standard is used for comparison to site soil data that have been converted to sample-specific TCDD-TEQ values through application of the Toxicity Equivalence Factor Methodology (USEPA 2010) and using the WHO 2005 Mammalian Toxic Equivalency Factors (TEFs)

Table 6 – Soil Leachate Remediation Standards for the Migration to Ground Water

Exposure Pathway (µg/L) (All ground water remediation standards are rounded to one significant figure[A]; all other numeric values are rounded to two significant figures)

Contaminant	CAS No.	Ground Water Remediation Standard	Soil Leachate Remediation Standard Migration to Ground Water
Acenaphthene	83-32-9	400	NA[1]
Acetone (2-Propanone)	67-64-1	6,000	120,000
Acetophenone	98-86-2	700	14,000
Aldrin	309-00-2	0.04	0.80
Aluminum (total)	7429-90-5	NA[2]	NA[2]
Anthracene	120-12-7	2,000	NA[1]
Antimony (total)	7440-36-0	6	120
Arsenic (total)	7440-38-2	3	60
Atrazine	1912-24-9	3	60
Barium (total)	7440-39-3	6,000	120,000
Benzaldehyde	100-52-7	NA[3]	NA[3]
Benzene	71-43-2	1	20
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	0.1	2.0
Benzo(a)pyrene	50-32-8	0.1	NA[1]
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	0.2	NA[1]
Benzo(k)fluoranthene	207-08-9	0.5	NA[1]
Beryllium	7440-41-7	1	20
1,1'-Biphenyl	92-52-4	400	NA[1]
Bis(2-chloroethoxy)methane	111-91-1	NA[3]	NA[3]
Bis(2-chloroethyl)ether	111-44-4	7	140
Bis(2-ethylhexyl)phthalate	117-81-7	3	60
Bromodichloromethane (Dichlorobromomethane)	75-27-4	1	20
Bromoform	75-25-2	4	80
Bromomethane (Methyl bromide)	74-83-9	10	200
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	300	6,000
Butylbenzyl phthalate	85-68-7	100	2,000
Cadmium	7440-43-9	4	80
Caprolactam	105-60-2	4,000	80,000
Carbon disulfide	75-15-0	700	14,000
Carbon tetrachloride	56-23-5	1	20

Chlordane (alpha and gamma forms summed)	**57-74-9**	**0.5**	**10**
4-Chloroaniline	**106-47-8**	**30**	**600**
Chlorobenzene	**108-90-7**	**50**	**1,000**
Chloroethane (Ethyl chloride)	**75-00-3**	**NA[3]**	**NA[3]**
Chloroform	**67-66-3**	**70**	**1,400**
Chloromethane (Methyl chloride)	**74-87-3**	**NA[3]**	**NA[3]**
2-Chloronaphthalene	**91-58-7**	**600**	**NA[1]**
2-Chlorophenol (o-Chlorophenol)	**95-57-8**	**40**	**800**
Chrysene	**218-01-9**	**5**	**NA[1]**
Cobalt (total)	**7440-48-4**	**100**	**2,000**
Copper (total)	**7440-50-8**	**1,300**	**26,000**
Cyanide	**57-12-5**	**100**	**2,000**
Cyclohexane	**110-82-7**	**NA[3]**	**NA[3]**
4,4'-DDD (p,p'-TDE)	**72-54-8**	**0.1**	**2.0**
4,4'-DDE (p,p'-DDX)	**72-55-9**	**0.1**	**2.0**
4,4'-DDT	**50-29-3**	**0.1**	**2.0**
Dibenz(a,h)anthracene	**53-70-3**	**0.3**	**NA[1]**
Dibromochloromethane (Chlorodibromomethane)	**124-48-1**	**1**	**20**
1,2-Dibromo-3-chloropropane	**96-12-8**	**0.02**	**0.40**
1,2-Dibromoethane (Ethylene dibromide)	**106-93-4**	**0.03**	**0.60**
1,2-Dichlorobenzene (o-Dichlorobenzene)	**95-50-1**	**600**	**12,000**
1,3-Dichlorobenzene (m-Dichlorobenzene)	**541-73-1**	**600**	**12,000**
1,4-Dichlorobenzene (p-Dichlorobenzene)	**106-46-7**	**75**	**1,500**
3,3'-Dichlorobenzidine	**91-94-1**	**30**	**600**
Dichlorodifluoromethane (Freon 12)	**75-71-8**	**1,000**	**20,000**
1,1-Dichloroethane	**75-34-3**	**50**	**1,000**
1,2-Dichloroethane	**107-06-2**	**2**	**40**
1,1-Dichloroethene (1,1-Dichloroethylene)	**75-35-4**	**1**	**20**
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	**156-59-2**	**70**	**1,400**
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	**156-60-5**	**100**	**2,000**
2,4-Dichlorophenol	**120-83-2**	**20**	**400**
1,2-Dichloropropane	**78-87-5**	**1**	**20**
1,3-Dichloropropene (total)	**542-75-6**	**1**	**20**
Dieldrin	**60-57-1**	**0.03**	**0.60**
Diethylphthalate	**84-66-2**	**6,000**	**120,000**

2,4-Dimethylphenol	**105-67-9**	**100**	**2,000**
Di-n-butyl phthalate	**84-74-2**	**700**	**NA[1]**
2,4-Dinitrophenol	**51-28-5**	**40**	**800**
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	**25321-14-6**	**10**	**200**
Di-n-octyl phthalate	**117-84-0**	**100**	**NA[1]**
1,4-Dioxane	**123-91-1**	**0.4**	**8.0**
Endosulfan I and Endosulfan II (alpha and beta) (summed)	**115-29-7**	**40**	**NA[1]**
Endrin	**72-20-8**	**2**	**40**
Ethylbenzene	**100-41-4**	**700**	**14,000**
Extractable Petroleum Hydrocarbons (Category 1)	**various**	**NA[3]**	**NA[3]**
Extractable Petroleum Hydrocarbons (Category 2)	**various**	**NA[3]**	**NA[3]**
Fluoranthene	**206-44-0**	**300**	**NA[1]**
Fluorene	**86-73-7**	**300**	**NA[1]**
alpha-HCH (alpha-BHC)	**319-84-6**	**0.02**	**0.40**
beta-HCH (beta-BHC)	**319-85-7**	**0.04**	**0.80**
Heptachlor	**76-44-8**	**0.05**	**1.0**
Heptachlor epoxide	**1024-57-3**	**0.2**	**4.0**
Hexachlorobenzene	**118-74-1**	**0.02**	**0.40**
Hexachloro-1,3-butadiene	**87-68-3**	**1**	**20**
Hexachlorocyclopentadiene	**77-47-4**	**40**	**800**
Hexachloroethane	**67-72-1**	**7**	**140**
n-Hexane	**110-54-3**	**30**	**600**
2-Hexanone	**591-78-6**	**40**	**800**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**0.2**	**NA[1]**
Isophorone	**78-59-1**	**40**	**800**
Isopropylbenzene	**98-82-8**	**700**	**14,000**
Lead (total)	**7439-92-1**	**5**	**100**
Lindane (gamma-HCH)(gamma-BHC)	**58-89-9**	**0.03**	**0.60**
Manganese (total)	**7439-96-5**	**NA[2]**	**NA[2]**
Mercury (total)	**7439-97-6**	**2**	**40**
Methoxychlor	**72-43-5**	**40**	**NA[1]**
Methyl acetate	**79-20-9**	**7,000**	**140,000**
Methylene chloride (Dichloromethane)	**75-09-2**	**3**	**60**
2-Methylnaphthalene	**91-57-6**	**30**	**600**
4-Methyl-2-pentanone (MIBK)	**108-10-1**	**NA[3]**	**NA[3]**
2-Methylphenol (o-cresol)	**95-48-7**	**50**	**1,000**

4-Methylphenol (p-cresol)	**106-44-5**	**50**	**1,000**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**70**	**1,400**
Naphthalene	**91-20-3**	**300**	**6,000**
Nickel (total)	**7440-02-0**	**100**	**2,000**
4-Nitroaniline	**100-01-6**	**NA[3]**	**NA[3]**
Nitrobenzene	**98-95-3**	**6**	**120**
N-Nitrosodi-n-propylamine	**621-64-7**	**10**	**200**
N-Nitrosodiphenylamine	**86-30-6**	**10**	**200**
2,2'-oxybis(1-chloropropane)	**108-60-1**	**300**	**6,000**
Pentachlorophenol	**87-86-5**	**0.3**	**6.0**
Phenol	**108-95-2**	**2,000**	**40,000**
Polychlorinated biphenyls (PCBs)	**1336-36-3**	**0.5**	**10**
Pyrene	**129-00-0**	**200**	**NA[1]**
Selenium (total)	**7782-49-2**	**40**	**800**
Silver (total)	**7440-22-4**	**40**	**800**
Styrene	**100-42-5**	**100**	**2,000**
Tertiary butyl alcohol (TBA)	**75-65-0**	**100**	**2,000**
1,2,4,5-Tetrachlorobenzene	**95-94-3**	**NA[3]**	**NA[3]**
2,3,7,8-Tetrachlorodibenzo-p-dioxin	**1746-01-6**	**0.00001**	**0.00020[4]**
1,1,2,2-Tetrachloroethane	**79-34-5**	**1**	**20**
Tetrachloroethene (PCE) (Tetrachloroethylene)	**127-18-4**	**1**	**20**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**200**	**4,000**
Toluene	**108-88-3**	**600**	**12,000**
Toxaphene	**8001-35-2**	**2**	**40**
1,2,4-Trichlorobenzene	**120-82-1**	**9**	**180**
1,1,1-Trichloroethane	**71-55-6**	**30**	**600**
1,1,2-Trichloroethane	**79-00-5**	**3**	**60**
Trichloroethene (TCE) (Trichloroethylene)	**79-01-6**	**1**	**20**
Trichlorofluoromethane (Freon 11)	**75-69-4**	**2,000**	**40,000**
2,4,5-Trichlorophenol	**95-95-4**	**700**	**14,000**
2,4,6-Trichlorophenol	**88-06-2**	**20**	**400**
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	**76-13-1**	**NA[3]**	**NA[3]**
1,2,4-Trimethylbenzene	**95-63-6**	**NA[3]**	**NA[3]**
Vanadium (total)	**7440-62-2**	**NA[3]**	**NA[3]**
Vinyl chloride	**75-01-4**	**1**	**20**
Xylenes (total)	**1330-20-7**	**1,000**	**20,000**
Zinc (total)	**7440-66-6**	**2,000**	**40,000**

[A] The ground water remediation standards are listed using one significant figure to be consistent with the Ground Water Quality Standards, N.J.A.C. 7:9C

NA – Not applicable

[1] Standard not applicable because the calculated health-based criterion exceeds the soil saturation limit

[2] Not applicable because ground water remediation standard is a secondary standard

[3] Not applicable because a ground water remediation standard does not exist

[4] This standard is used for comparison to site soil leachate data that have been converted to sample-specific TCDD-TEQ values through application of the Toxicity Equivalence Factor Methodology (USEPA 2010) and using the WHO 2005 Mammalian Toxic Equivalency Factors (TEFs)

Table 7 – Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway - Residential (µg/m^3) (All numeric values are rounded to two significant figures)

Contaminant	CAS No.	Carcinogenic Indoor Air Human Health-based Criterion	Noncarcinogenic Indoor Air Human Health-based Criterion	Reporting Limit	Indoor Air Remediation Standard Residential
Acetone	67-64-1	NA	NA	12	NA
Benzene	71-43-2	0.36	31	0.64	0.64[1]
Bromodichloromethane	75-27-4	NA	NA	1.3	NA
Bromoform	75-25-2	NA	NA	2.1	NA
Bromomethane (Methyl bromide)	74-83-9	NA	5.2	0.78	5.2
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	NA	5,200	1.5	5,200
Carbon disulfide	75-15-0	NA	730	1.6	730
Carbon tetrachloride	56-23-5	0.47	100	1.3	1.3[1]

Chlorobenzene	**108-90-7**	**NA**	**52**	**0.92**	**52**
Chloroethane (Ethyl chloride)	**75-00-3**	**NA**	**10,000**	**1.3**	**10,000**
Chloroform	**67-66-3**	**NA**	**100**	**0.98**	**100**
Chloromethane (Methyl chloride)	**74-87-3**	**NA**	**94**	**1.0**	**94**
Cyclohexane	**110-82-7**	**NA**	**6,300**	**0.69**	**6,300**
Dibromochloromethane	**124-48-1**	**NA**	**NA**	**1.7**	**NA**
1,2-Dibromoethane (Ethylene dibromide)	**106-93-4**	**0.0047**	**9.4**	**1.5**	**1.5[1]**
1,2-Dichlorobenzene (o-Dichlorobenzene)	**95-50-1**	**NA**	**210**	**1.2**	**210**
1,4-Dichlorobenzene (p-Dichlorobenzene)	**106-46-7**	**NA**	**830**	**1.2**	**830**
Dichlorodifluoromethane (Freon 12)	**75-71-8**	**NA**	**NA**	**2.5**	**NA**
1,1-Dichloroethane	**75-34-3**	**NA**	**NA**	**0.81**	**NA**
1,2-Dichloroethane	**107-06-2**	**NA**	**7.3**	**0.81**	**7.3**
1,1-Dichloroethene (1,1-Dichloroethylene)	**75-35-4**	**NA**	**21**	**0.79**	**21**
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	**156-59-2**	**NA**	**NA**	**0.79**	**NA**
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	**156-60-5**	**NA**	**NA**	**0.79**	**NA**
1,2-Dichloropropane	**78-87-5**	**0.76**	**4.2**	**0.92**	**0.92[1]**
1,3-Dichloropropene (total)	**542-75-6**	**0.70**	**21**	**0.91**	**0.91[1]**
1,4-Dioxane	**123-91-1**	**0.56**	**31**	**0.72**	**0.72[1]**
Ethylbenzene	**100-41-4**	**1.1**	**1,000**	**0.87**	**1.1**
Hexachlorobutadiene	**87-68-3**	**NA**	**NA**	**2.1**	**NA**
n-Hexane	**110-54-3**	**NA**	**730**	**0.70**	**730**
Mercury (elemental)	**7439-97-6**	**NA**	**0.31**	**1.0**	**1.0[1]**
Methylene chloride (Dichloromethane)	**75-09-2**	**280**	**630**	**1.7**	**280**
4-Methyl-2-pentanone (MIBK)	**108-10-1**	**NA**	**3,100**	**2.0**	**3,100**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**11**	**3,100**	**0.72**	**11**
Naphthalene	**91-20-3**	**0.083**	**3.1**	**2.6**	**2.6[1]**
Styrene	**100-42-5**	**NA**	**1,000**	**0.85**	**1,000**
1,1,2,2-Tetrachloroethane	**79-34-5**	**NA**	**NA**	**1.4**	**NA**

Tetrachloroethene (PCE) (Tetrachloroethylene)	127-18-4	11	42	1.4	11
Toluene	108-88-3	NA	5,200	0.75	5,200
1,2,4-Trichlorobenzene	120-82-1	NA	2.1	3.7	3.7[1]
1,1,1-Trichloroethane	71-55-6	NA	5,200	1.1	5,200
1,1,2-Trichloroethane	79-00-5	NA	NA	1.1	NA
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	0.68	2.1	1.1	1.1[1]
Trichlorofluoromethane	75-69-4	NA	NA	1.1	NA
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	76-13-1	NA	5,200	1.5	5,200
1,2,4-Trimethylbenzene	95-63-6	NA	63	0.98	63
Vinyl chloride	75-01-4	0.64	100	0.51	0.64
Xylenes (total)	1330-20-7	NA	100	0.87	100

NA – Not applicable because appropriate toxicological information is not available

[1] Standard set at reporting limit

Table 8 – Indoor Air Remediation Standards for the Vapor Intrusion Exposure Pathway - Nonresidential (µg/m^3) (All numeric values are rounded to two significant figures)

Contaminant	CAS No.	Carcinogenic Indoor Air Human Health-based Criterion	Noncarcinogenic Indoor Air Human Health-based Criterion	Reporting Limit	Indoor Air Remediation Standard Nonresidential
Acetone	67-64-1	NA	NA	12	NA
Benzene	71-43-2	1.6	130	0.64	1.6
Bromodichloromethane	75-27-4	NA	NA	1.3	NA
Bromoform	75-25-2	NA	NA	2.1	NA
Bromomethane (Methyl bromide)	74-83-9	NA	22	0.78	22
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	NA	22,000	1.5	22,000
Carbon disulfide	75-15-0	NA	3,100	1.6	3,100
Carbon tetrachloride	56-23-5	2.0	440	1.3	2.0
Chlorobenzene	108-90-7	NA	220	0.92	220
Chloroethane (Ethyl chloride)	75-00-3	NA	44,000	1.3	44,000

Chloroform	**67-66-3**	**NA**	**430**	**0.98**	**430**
Chloromethane (Methyl chloride)	**74-87-3**	**NA**	**390**	**1.0**	**390**
Cyclohexane	**110-82-7**	**NA**	**26,000**	**0.69**	**26,000**
Dibromochloromethane	**124-48-1**	**NA**	**NA**	**1.7**	**NA**
1,2-Dibromoethane (Ethylene dibromide)	**106-93-4**	**0.020**	**39**	**1.5**	**1.5[1]**
1,2-Dichlorobenzene (o-Dichlorobenzene)	**95-50-1**	**NA**	**880**	**1.2**	**880**
1,4-Dichlorobenzene (p-Dichlorobenzene)	**106-46-7**	**NA**	**3,500**	**1.2**	**3,500**
Dichlorodifluoromethane (Freon 12)	**75-71-8**	**NA**	**NA**	**2.5**	**NA**
1,1-Dichloroethane	**75-34-3**	**NA**	**NA**	**0.81**	**NA**
1,2-Dichloroethane	**107-06-2**	**NA**	**31**	**0.81**	**31**
1,1-Dichloroethene (1,1-Dichloroethylene)	**75-35-4**	**NA**	**88**	**0.79**	**88**
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	**156-59-2**	**NA**	**NA**	**0.79**	**NA**
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	**156-60-5**	**NA**	**NA**	**0.79**	**NA**
1,2-Dichloropropane	**78-87-5**	**3.3**	**18**	**0.92**	**3.3**
1,3-Dichloropropene (total)	**542-75-6**	**3.1**	**88**	**0.91**	**3.1**
1,4-Dioxane	**123-91-1**	**2.5**	**130**	**0.72**	**2.5**
Ethylbenzene	**100-41-4**	**4.9**	**4,400**	**0.87**	**4.9**
Hexachlorobutadiene	**87-68-3**	**NA**	**NA**	**2.1**	**NA**
n-Hexane	**110-54-3**	**NA**	**3,100**	**0.70**	**3,100**
Mercury (elemental)	**7439-97-6**	**NA**	**1.3**	**1.0**	**1.3**
Methylene chloride (Dichloromethane)	**75-09-2**	**1,200**	**2,600**	**1.7**	**1,200**
4-Methyl-2-pentanone (MIBK)	**108-10-1**	**NA**	**13,000**	**2.0**	**13,000**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**47**	**13,000**	**0.72**	**47**
Naphthalene	**91-20-3**	**0.36**	**13**	**2.6**	**2.6[1]**
Styrene	**100-42-5**	**NA**	**4,400**	**0.85**	**4,400**
1,1,2,2-Tetrachloroethane	**79-34-5**	**NA**	**NA**	**1.4**	**NA**
Tetrachloroethene (PCE) (Tetrachloroethylene)	**127-18-4**	**47**	**180**	**1.4**	**47**
Toluene	**108-88-3**	**NA**	**22,000**	**0.75**	**22,000**
1,2,4-Trichlorobenzene	**120-82-1**	**NA**	**8.8**	**3.7**	**8.8**
1,1,1-Trichloroethane	**71-55-6**	**NA**	**22,000**	**1.1**	**22,000**

1,1,2-Trichloroethane	**79-00-5**	**NA**	**NA**	**1.1**	**NA**
Trichloroethene (TCE) (Trichloroethylene)	**79-01-6**	**3.0**	**8.8**	**1.1**	**3.0**
Trichlorofluoromethane	**75-69-4**	**NA**	**NA**	**1.1**	**NA**
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	**76-13-1**	**NA**	**22,000**	**1.5**	**22,000**
1,2,4-Trimethylbenzene	**95-63-6**	**NA**	**260**	**0.98**	**260**
Vinyl chloride	**75-01-4**	**2.8**	**440**	**0.51**	**2.8**
Xylenes (total)	**1330-20-7**	**NA**	**440**	**0.87**	**440**

NA – Not applicable because appropriate toxicological information is not available

[1] Standard set at reporting limit

APPENDIX 2

DEVELOPMENT OF SOIL REMEDIATION STANDARDS FOR THE INGESTION-DERMAL EXPOSURE PATHWAY

This appendix describes the procedures and equations used by the Department to develop the soil remediation standards for the ingestion-dermal exposure pathway as contained in N.J.A.C. 7:26D Appendix 1 Tables 1 and 2. This appendix is also used to develop interim soil remediation standards for the ingestion-dermal exposure pathway pursuant to N.J.A.C. 7:26D-6 and for updating soil remediation standards for the ingestion-dermal exposure pathway pursuant to N.J.A.C. 7:26D-7.

If the calculated soil criterion for a contaminant for the ingestion-dermal exposure pathway is greater than one million mg/kg, a soil remediation standard for the ingestion-dermal exposure pathway for that contaminant does not apply.

If the calculated soil criterion for a contaminant for the ingestion-dermal exposure pathway is less than the reporting limit for that contaminant, the soil remediation standard for the ingestion-dermal exposure pathway for that contaminant defaults to the soil reporting limit.

Equations 1 through 4 below are derived from the USEPA, Regional Screening Levels (RSLs) – Equations (November 2018). A detailed explanation of the derivation of Equations 1 through 4 is contained at N.J.A.C. 7:26D Appendix 12.

Equation 1 – Residential Carcinogenic Ingestion-Dermal Human Health-Based Criteria

$$ID_c = \frac{TR * AT * LT}{(10^{-6} kg/mg) * [(CSF_O * IFS_{adj}) + (CSF_D * DFS_{adj} * ABS_d)]}$$

Parameter	Definition	Units	Default
ID_c	Carcinogenic ingestion-dermal human health-based criterion	mg/kg	Chemical specific
TR	Target cancer risk	unitless	1×10^{-6}
AT	Averaging time	days/year	365

LT	**Lifetime**	**years**	**70**
CSF_o	**Oral cancer slope factor**	**$(mg/kg\text{-}day)^{-1}$**	**Chemical specific**
IFS_{adj}	**Age-adjusted soil ingestion rate**	**mg/kg**	**36,750**
CSF_D	**Dermal cancer slope factor**	**$(mg/kg\text{-}day)^{-1}$**	**Chemical specific**
DFS_{adj}	**Age-adjusted soil dermal contact factor**	**mg/kg**	**103,390**
ABS_d	**Dermal absorption fraction**	**unitless**	**Chemical specific**

Where:

$$IFS_{adj} = \frac{EF_c * ED_c * IR_c}{BW_c} + \frac{EF_a * ED_a * IR_a}{BW_a}$$

Parameter	Definition	Units	Default
IFS_{adj}	**Age-adjusted soil ingestion rate**	**mg/kg**	**36,750**
EF_c	**Exposure frequency – child**	**days/year**	**350**
EF_a	**Exposure frequency – adult**	**days/year**	**350**
ED_c	**Exposure duration – child**	**years**	**6**
ED_a	**Exposure duration – adult**	**years**	**20**
IR_c	**Soil ingestion rate – child**	**mg/day**	**200**
IR_a	**Soil ingestion rate – adult**	**mg/day**	**100**
BW_c	**Body weight – child**	**kg**	**15**
BW_a	**Body weight – adult**	**kg**	**80**

Where:

$$DFS_{adj} = \frac{EF_c * ED_c * SA_c * AF_c}{BW_c} + \frac{EF_a * ED_a * SA_a * AF_a}{BW_a}$$

Parameter	Definition	Units	Default
DFS_{adj}	Age-adjusted soil dermal contact factor	mg/kg	103,390
EF_c	Exposure frequency – child	days/year	350
EF_a	Exposure frequency – adult	days/year	350
ED_c	Exposure duration – child	years	6
ED_a	Exposure duration – adult	years	20
SA_c	Skin surface area – child	cm^2/day	2,373
SA_a	Skin surface area – adult	cm^2/day	6,032
AF_c	Soil adherence factor – child	mg/cm^2	0.2
AF_a	Soil adherence factor – adult	mg/cm^2	0.07
BW_c	Body weight – child	kg	15
BW_a	Body weight – adult	kg	80

Where:

$$CSF_D = \frac{CSF_O}{GIABS}$$

Parameter	Definition	Units	Default
CSF_D	Dermal cancer slope factor	$(mg/kg\text{-}day)^{-1}$	Chemical specific
CSF_O	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	Chemical specific
GIABS	Gastro-intestinal absorption fraction	unitless	Chemical specific

Equation 2 – Residential Noncarcinogenic Ingestion-Dermal Human Health-Based Criteria

$$ID_{nc} = \frac{THQ * AT * ED * BW}{(EF * ED * 10^{-6} kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$$

Parameter	Definition	Units	Default
ID_{nc}	Noncarcinogenic ingestion-dermal human health-based criterion	mg/kg	Chemical specific
THQ	Target hazard quotient	unitless	1
AT	Averaging time	days/year	365
ED	Exposure duration	years	6
BW	Body weight-child	kg	15
EF	Exposure frequency	days/year	350
RfD_O	Oral reference dose	mg/kg-day	Chemical specific
IR	Soil ingestion rate-child	mg/day	200
RfD_D	Dermal	mg/kg-day	Chemical specific

	reference dose		
SA	**Skin surface area -child**	**cm^2/day**	**2,373**
AF	**Soil adherence factor-child**	**mg/cm^2**	**0.2**
ABS_d	**Dermal absorption fraction**	**unitless**	**Chemical specific**

Where:

$$RfD_D = RfD_O * GIABS$$

Parameter	**Definition**	**Units**	**Default**
RfD_D	**Dermal reference dose**	**mg/kg-day**	**Chemical specific**
RfD_O	**Oral reference dose**	**mg/kg-day**	**Chemical specific**
GIABS	**Gastro-intestinal absorption fraction**	**unitless**	**Chemical specific**

Equation 3 – Nonresidential Carcinogenic Ingestion-Dermal Human Health-Based Criteria

$$ID_c = \frac{TR * AT * LT * BW}{EF * ED * 10^{-6} kg/mg * [(CSF_O * IR) + (CSF_D * SA * AF * ABS_d)]}$$

Parameter	**Definition**	**Units**	**Default**

ID_c	**Carcinogenic ingestion-dermal human health-based criterion**	**mg/kg**	**Chemical specific**
TR	**Target cancer risk**	**unitless**	**1×10^{-6}**
AT	**Averaging time**	**days/year**	**365**
LT	**Lifetime**	**years**	**70**
BW	**Body weight - adult**	**kg**	**80**
EF	**Exposure frequency-outdoor worker**	**days/year**	**225**
ED	**Exposure duration**	**years**	**25**
CSF_o	**Oral cancer slope factor**	**$(mg/kg\text{-}day)^{-1}$**	**Chemical specific**
IR	**Soil ingestion rate -outdoor worker**	**mg/day**	**100**
CSF_D	**Dermal cancer slope factor**	**$(mg/kg\text{-}day)^{-1}$**	**Chemical specific**
SA	**Skin surface area - worker**	**cm^2/day**	**3,527**
AF	**Soil adherence factor-worker**	**mg/cm^2**	**0.12**
ABS_d	**Dermal absorption fraction**	**unitless**	**Chemical specific**

Where:

$$CSF_D = \frac{CSF_O}{GIABS}$$

Parameter	**Definition**	**Units**	**Default**

CSF_D	**Dermal cancer slope factor**	**$(mg/kg\text{-}day)^{-1}$**	**Chemical specific**
CSF_O	**Oral cancer slope factor**	**$(mg/kg\text{-}day)^{-1}$**	**Chemical specific**
GIABS	**Gastro-intestinal absorption fraction**	**unitless**	**Chemical specific**

Equation 4 – Nonresidential Noncarcinogenic Ingestion-Dermal Human Health-Based Criteria

$$ID_{nc} = \frac{THQ * AT * ED * BW}{(EF * ED * 10^{-6}\, kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$$

Parameter	Definition	Units	Default
ID_{nc}	**Noncarcinogenic ingestion-dermal human health-based criterion**	**mg/kg**	**Chemical specific**
THQ	**Target hazard quotient**	**unitless**	**1**
AT	**Averaging time**	**days/year**	**365**
ED	**Exposure duration**	**years**	**25**
BW	**Body weight-adult**	**kg**	**80**
EF	**Exposure frequency- outdoor worker**	**days/year**	**225**
RfD_O	**Oral reference dose**	**mg/kg-day**	**Chemical specific**
IR	**Soil ingestion rate- outdoor worker**	**mg/day**	**100**

RfD_D	**Dermal reference dose**	**mg/kg-day**	**Chemical specific**
SA	**Skin surface area - worker**	**cm^2/day**	**3,527**
AF	**Soil adherence factor-worker**	**mg/cm^2**	**0.12**
ABS_d	**Dermal absorption fraction**	**unitless**	**Chemical specific**

Where:

$$RfD_D = RfD_O * GIABS$$

Parameter	**Definition**	**Units**	**Default**
RfD_D	**Dermal reference dose**	**mg/kg-day**	**Chemical specific**
RfD_O	**Oral reference dose**	**mg/kg-day**	**Chemical specific**
GIABS	**Gastro-intestinal absorption fraction**	**unitless**	**Chemical specific**

Equation 5 – Residential and Nonresidential Noncarcinogenic Ingestion-Dermal Human Health-Based Criteria for EPH

$$ID_{nc} = \frac{THQ}{\frac{f_{(1)}}{ECFV_{(1)}} + \frac{f_{(2)}}{ECFV_{(2)}} + \frac{f_{(3)}}{ECFV_{(3)}} + \frac{f_{(4)}}{ECFV_{(4)}} + \frac{f_{(5)}}{ECFV_{(5)}} + \frac{f_{(6)}}{ECFV_{(6)}} + \frac{f_{(7)}}{ECFV_{(7)}} + \frac{f_{(8)}}{ECFV_{(8)}}}$$

Parameter	**Definition**	**Units**	**Default**

ID_{nc}	**Noncarcinogenic soil criterion for the ingestion-dermal exposure pathway**	**mg/kg**	**Chemical specific**
THQ	**Target hazard quotient**	**unitless**	**1**
f	**Equivalent carbon weight fraction**	**unitless**	**Chemical specific**
ECFV	**Equivalent carbon fraction value**	**mg/kg**	**Chemical specific**

ID_{nc} is the noncarcinogenic soil criterion for the ingestion-dermal exposure pathway for total EPH for the EPH composition established by the eight equivalent carbon (EC) range fractions. This equation was used to calculate a single numeric total EPH soil criterion for EPH (Category 1). This equation will be used to calculate a sample-specific total EPH soil criterion for all EPH (Category 2) using the Department's online EPH Calculator.

The equivalent carbon fraction value (ECFV) equation and default input variables are the same as used to calculate the noncarcinogenic soil criteria for the specific individual contaminants for the ingestion-dermal absorption exposure pathway shown in Equations 2 and 4. That is, each EC range is treated as if it is a single contaminant.

APPENDIX 3

DEVELOPMENT OF SOIL REMEDIATION STANDARDS FOR THE INHALATION EXPOSURE PATHWAY

This appendix describes the procedures and equations used by the Department to develop the soil remediation standards for the inhalation exposure pathway as contained in N.J.A.C. 7:26D Appendix 1, Tables 3 and 4. This appendix is also used to develop interim soil remediation standards for the inhalation exposure pathway pursuant to N.J.A.C. 7:26D-6 and for updating soil remediation standards for the inhalation exposure pathway pursuant to N.J.A.C. 7:26D-7. If a calculated soil criterion for a contaminant for the inhalation exposure pathway is greater than its soil saturation limit for the volatile portion of the equation, the volatile component of the equation is not applicable in the development of the soil criterion for the inhalation exposure pathway.

If the calculated soil criterion for a contaminant for the inhalation exposure pathway is greater than one million parts per million, a soil remediation standard for that contaminant for the inhalation exposure pathway does not apply.

If the calculated soil criterion for a contaminant for the inhalation exposure pathway is less than the soil reporting limit for that contaminant, the soil remediation standard for that contaminant for the inhalation exposure pathway defaults to the soil reporting limit.

Equations 1 through 7 below are derived from the USEPA, Regional Screening Levels (RSLs) – Equations (November 2018). A detailed explanation of the derivation of Equations 1 and 2 is contained in N.J.A.C. 7:26D Appendix 12.

Equation 1 – Carcinogenic Inhalation Human Health-Based Criteria

$$Inh_c = \frac{TR * AT * LT}{IUR * 1000\,{}^{\mu g}\!/_{mg} * EF * \left(\frac{1}{VF} + \frac{1}{PEF}\right) * ED * ET * \frac{1day}{24hours}}$$

Parameter	Definition	Units	Default
Inh_c	Carcinogenic inhalation human health-based criterion	mg/kg	Chemical specific
TR	Target cancer risk	unitless	1×10^{-6}
AT	Averaging time	days/year	365
LT	Lifetime	years	70
IUR	Inhalation unit risk factor	$(\mu g/m^3)^{-1}$	Chemical specific
EF	Exposure frequency	days/year	350 (Residential) 225 (Nonresidential)
VF	Soil-to-air volatilization factor	m^3/kg	Chemical specific
PEF	Particulate emission factor	m^3/kg	1.67×10^9 (Residential) 1.64×10^9 (Nonresidential)
ED	Exposure duration	years	26 (Residential) 25 (Nonresidential)

ET	**Exposure time**	**hours/day**	**24 (Residential)** **8 (Nonresidential)**

Equation 2 – Noncarcinogenic Inhalation Human Health-Based Criteria

$$Inh_{nc} = \frac{THQ * AT * ED}{EF * ED * ET * \frac{1day}{24hours} * \frac{1}{RfC} * \left(\frac{1}{VF} + \frac{1}{PEF}\right)}$$

Parameter	Definition	Units	Default
Inh_{nc}	**Noncarcinogenic inhalation human health-based criterion**	**mg/kg**	**Chemical specific**
THQ	**Target hazard quotient**	**unitless**	**1**
AT	**Averaging time**	**days/year**	**365**
EF	**Exposure frequency**	**days/year**	**350 (Residential)** **225 (Nonresidential)**
ED	**Exposure duration**	**years**	**26 (Residential)** **25 (Nonresidential)**
ET	**Exposure time**	**hours/day**	**24 (Residential)** **8 (Nonresidential)**
RfC	**Reference concentration**	**mg/m^3**	**Chemical specific**
VF	**Soil-to-air volatilization factor**	**m^3/kg**	**Chemical specific**
PEF	**Particulate emission factor**	**m^3/kg**	**1.67×10^9 (Residential)** **1.64×10^9 (Nonresidential)**

Equation 3 – Volatilization Factor (VF)

$$VF = Q/C * \frac{(3.14 * D_A * T)^{1/2}}{(2 * \rho_b * D_A)} * 10^{-4} \; m^2/cm^2$$

Parameter	Definition	Units	Default
VF	Soil-to-air volatilization factor	m^3/kg	Chemical specific
Q/C	Inverse concentration at center of source	$(g/m^2\text{-}s)/(kg/m^3)$	86.6 (Residential) 85 (Nonresidential)
D_A	Apparent diffusivity	cm^2/s	Chemical specific
T	Exposure interval	seconds	8.20×10^8
ρ_b	Dry soil bulk density	g/cm^3	1.5

Equation 4 – Apparent Diffusivity (D_A)

$$D_A = \frac{\left[\left(\theta_a^{10/3} * D_i * H'\right) + \left(\theta_w^{10/3} * D_w\right)\right] / n^2}{\left(\rho_b * K_d\right) + \theta_w + \left(\theta_a * H'\right)}$$

Parameter	Definition	Units	Default
D_A	Apparent diffusivity	cm^2/s	Chemical specific
Θ_a	Air-filled soil porosity	L_{air}/L_{soil}	0.18
D_i	Diffusivity in air	cm^2/s	Chemical

			specific
H'	**Henry's law constant**	**unitless**	**Chemical specific**
Θ_w	**Water-filled soil porosity**	**L_{water}/L_{soil}**	**0.23**
D_w	**Diffusivity in water**	**cm^2/s**	**Chemical specific**
n	**Total soil porosity**	**L_{pore}/L_{soil}**	**0.41**
ρ_b	**Dry soil bulk density**	**g/cm^3**	**1.5**
K_d	**Soil-water partition coefficient**	**cm^3/g**	**Chemical specific**

Equation 5 – Soil-Water Partition Coefficient (K_d)

$$K_d = K_{oc} * f_{oc}$$

Parameter	Definition	Units	Default
K_d	**Soil-water partition coefficient**	**cm^3/g**	**Chemical specific**
K_{oc}	**Soil organic carbon-water partition coefficient**	**cm^3/g**	**Chemical specific**
f_{oc}	**Organic carbon content of soil**	**g/g**	**0.002**

Equation 6 – Particulate Emission Factor (PEF)

$$PEF = Q/C * \left[\frac{3{,}600\ sec/hr}{0.036 * (1 - v) * \left(\frac{U_m}{U_t}\right)^3 * F(x)} \right]$$

Parameter	Definition	Units	Default
PEF	**Particulate emission factor**	**m^3/kg**	**1.67×10^9 (Residential) 1.64×10^9 (Nonresidential)**
Q/C	**Inverse concentration at center of source**	**$(g/m^2\text{-}s)/(kg/m^3)$**	**86.6 (Residential) 85 (Nonresidential)**
v	**Percent vegetative cover**	**percent**	**50**
Um	**Mean annual wind speed**	**m/s**	**4.56**
Ut	**Equivalent threshold value of wind speed at 7 m**	**m/s**	**11.32**
F(x)	**Function dependent on Um/Ut derived using Cowherd et al. (1985)**	**unitless**	**0.159**

Equation 7–Soil Saturation Limit (C_{sat})

$$C_{sat} = \frac{S}{\rho_b} * \left[(K_d * \rho_b) + \theta_w + (H' * \theta_a) \right]$$

Parameter	Definition	Units	Default
C_{sat}	**Soil saturation limit**	**mg/kg**	**Chemical specific**

S	**Water solubility**	**mg/L_{water}**	**Chemical specific**
ρ_b	**Dry soil bulk density**	**g/cm^3**	**1.5**
K_d	**Soil-water partition coefficient**	**cm^3/g**	**Chemical specific**
Θ_w	**Water-filled soil porosity**	**L_{water}/L_{soil}**	**0.23**
H'	**Henry's law constant**	**unitless**	**Chemical specific**
Θ_a	**Air-filled soil porosity**	**L_{air}/L_{soil}**	**0.18**

APPENDIX 4

DEVELOPMENT OF THE SOIL AND SOIL LEACHATE REMEDIATION STANDARDS FOR THE MIGRATION TO GROUND WATER EXPOSURE PATHWAY

This appendix describes the procedures used by the Department to develop the soil and soil leachate remediation standards for the migration to ground water exposure pathway as contained at N.J.A.C. 7:26D Appendix 1, Tables 5 and 6. This appendix is also used to develop interim soil and soil leachate remediation standards for the migration to ground water exposure pathway pursuant to N.J.A.C. 7:26D-6 and for updating soil and soil leachate remediation standards for the migration to ground water exposure pathway pursuant to N.J.A.C. 7:26D-7.

If a calculated soil criterion for a contaminant for the migration to ground water exposure pathway is greater than its soil saturation limit, a soil remediation standard for the migration to ground water exposure pathway does not apply.

If a calculated soil criterion for a contaminant for migration to ground water exposure pathway is less than the soil reporting limit for that contaminant, the soil remediation standard for the migration to ground water remediation exposure pathway defaults to the soil reporting limit.

Equation 1a – Migration to Ground Water Soil-Water Partitioning Criteria for Inorganic Contaminants

Source: USEPA Soil Screening Guidance: Technical Background Document EPA/540/R-95/128 (May 1996) (Equation 22)

$$MGW_c = GWRS * \frac{mg}{1000\mu g} * \left\{ K_d + \frac{\theta_w + (\theta_a * H')}{\rho_b} \right\} * DAF$$

Parameter	Definition	Units	Default
MGW_c	Migration to ground water soil-water partitioning criterion	mg/kg	Chemical specific
GWRS	Ground water remediation standard	µg/L	Chemical specific
K_d	Soil-water partition coefficient	L/kg	Chemical specific

ϑ_w	**Water-filled soil porosity**	**L_{water}/L_{soil}**	**0.23**
ϑ_a	**Air-filled soil porosity**	**L_{air}/L_{soil}**	**0.18**
H'	**Henry's law constant**	**unitless**	**Chemical specific**
ρ_b	**Dry soil bulk density**	**kg/L**	**1.5**
DAF	**Dilution-attenuation factor**	**unitless**	**20**

Equation 1b– Migration to Ground Water Soil-Water Partitioning Criteria for Organic Contaminants

Source: USEPA Soil Screening Guidance: Technical Background Document EPA/540/R-95/128 (May 1996) (Equation 24)

$$MGW_c = GWRS * \frac{mg}{1000\mu g} * \left\{ (K_{oc} * f_{oc}) + \frac{\theta_w + (\theta_a * H')}{\rho_b} \right\} * DAF$$

Parameter	Definition	Units	Default
MGW_c	**Migration to ground water soil-water partitioning criterion**	**mg/kg**	**Chemical specific**
GWRS	**Ground water remediation standard**	**µg/L**	**Chemical specific**
K_{oc}	**Soil organic carbon-water partition coefficient**	**L/kg**	**Chemical specific**
f_{oc}	**Organic carbon content of soil**	**kg/kg**	**0.002**
ϑ_w	**Water-filled soil porosity**	**L_{water}/L_{soil}**	**0.23**
ϑ_a	**Air-filled soil porosity**	**L_{air}/L_{soil}**	**0.18**

H'	**Henry's law constant**	**unitless**	**Chemical specific**
ρ_b	**Dry soil bulk density**	**kg/L**	**1.5**
DAF	**Dilution-attenuation factor**	**unitless**	**20**

Equation 2 – Dilution-Attenuation Factor

Source: USEPA Soil Screening Guidance: Technical Background Document EPA/540/R-95/128

(May 1996) (Equation 37)

$$DAF = 1 + \frac{K * i * d}{I * L}$$

Parameter	Definition	Units	Default
DAF	**Dilution-attenuation factor**	**unitless**	**20**
K	**Aquifer hydraulic conductivity**	**m/year**	**15,808**
i	**Hydraulic gradient**	**m/m**	**0.003**
d	**Mixing zone depth**	**m**	**3.4**
I	**Infiltration rate**	**m/year**	**0.28**
L	**Length of area of concern parallel to ground water flow**	**m**	**30.5**

Equation 3 – Mixing Zone Depth

Source: USEPA Soil Screening Guidance: Technical Background Document EPA/540/R-95/128

(May 1996) (Equation 45)

$$d = (0.0112 * L^2)^{0.5} + d_a * \{1 - \exp[(-L * I)/(K * i * d_a)]\}$$

Parameter	Definition	Units	Default
d	**Mixing zone depth**	**m**	**3.4**
L	**Length of area of concern parallel to ground water flow**	**m**	**30.5**
d_a	**Aquifer thickness**	**m**	**3.5**
I	**Infiltration rate**	**m/year**	**0.28**
K	**Aquifer hydraulic conductivity**	**m/year**	**15,808**
i	**Hydraulic gradient**	**m/m**	**0.003**

Equation 4 – Soil Saturation Limit

Source: USEPA Soil Screening Guidance: Technical Background Document EPA/540/R-95/128

(May 1996) (Equation 9)

$$C_{sat} = \frac{S}{\rho_b} * [(K_{oc} * f_{oc} * \rho_b) + \theta_w + (H' * \theta_a)]$$

Parameter	Definition	Units	Default
C_{sat}	Soil saturation limit	mg/kg	Chemical specific
S	Water solubility	mg/L	Chemical specific
ρ_b	Dry soil bulk density	kg/L	1.5
K_{oc}	Soil organic carbon-water partition coefficient	L/kg	Chemical specific
f_{oc}	Organic carbon content of soil	kg/kg	0.002
ϑ_w	Water-filled soil porosity	L_{water}/L_{soil}	0.23
H'	Henry's law constant	unitless	Chemical specific
ϑ_a	Air-filled soil porosity	L_{air}/L_{soil}	0.18

Equation 5 – Soil Leachate Remediation Standards for the Migration to Ground Water Exposure Pathway

Source: USEPA Soil Screening Guidance: Technical Background Document EPA/540/R-95/128 (May 1996) (Target soil leachate concentration parameter in Equations 22 and 24)

$$MGW_{leachate} = GWRS * DAF$$

Parameter	Definition	Units	Default
$MGW_{leachate}$	Soil leachate remediation standard for the migration to ground water exposure pathway	µg/L	Chemical specific

GWRS	**Ground water remediation standard**	**µg/L**	**Chemical specific**
DAF	**Dilution-attenuation factor**	**unitless**	**20**

APPENDIX 5

DEVELOPMENT OF INDOOR AIR REMEDIATION STANDARDS FOR THE VAPOR INTRUSION EXPOSURE PATHWAY

This appendix describes the procedures and equations used by the Department to develop the indoor air remediation standards for the vapor intrusion exposure pathway as contained at N.J.A.C. 7:26D Appendix 1, Tables 7 and 8. This appendix is also used to develop interim indoor air remediation standards for the vapor intrusion exposure pathway pursuant to N.J.A.C. 7:26D-6 and for updating indoor air remediation standards for the vapor intrusion exposure pathway pursuant to N.J.A.C. 7:26D-7.

If the calculated indoor air human health-based criterion for a contaminant is less than the reporting limit, the indoor air remediation standard defaults to the reporting limit.

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Equations 1 and 2 below are derived from the USEPA, Regional Screening Levels (RSLs) – Equations (November 2018). A detailed explanation of the derivation of Equations 1 and 2 is contained at N.J.A.C. 7:26D Appendix 12.

Equation 1 – Carcinogenic Indoor Air Human Health-Based Criteria

$$IA_c = \frac{TR * AT * LT}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * IUR}$$

Parameter	Definition	Units	Default
IA_c	Carcinogenic indoor air human health-based criterion	µg/m^3	Chemical specific
TR	Target cancer risk	unitless	1 x 10^{-6}
AT	Averaging time	days/year	365
LT	Lifetime	years	70
EF	Exposure frequency	days/year	350 (Residential) 250 (Nonresidential-indoor worker)
ED	Exposure duration	years	26 (Residential) 25 (Nonresidential)
ET	Exposure time	hours/day	24 (Residential) 8 (Nonresidential)
IUR	Inhalation unit risk	(µg/m^3)$^{-1}$	Chemical specific

Equation 2 – Noncarcinogenic Indoor Air Human Health-Based Criteria

$$IA_{nc} = \frac{THQ * AT * ED * \frac{1000\,\mu g}{mg}}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * \frac{1}{RfC}}$$

Parameter	Definition	Units	Default
IA_{nc}	Noncarcinogenic indoor air human health-based criterion	µg/m^3	Chemical specific
THQ	Target hazard quotient	unitless	1
AT	Averaging time	days/year	365
ED	Exposure duration	years	26 (Residential) 25 (Nonresidential)
EF	Exposure frequency	days/year	350 (Residential) 250 (Nonresidential-indoor worker)
ET	Exposure time	hours/day	24 (Residential) 8 (Nonresidential)
RfC	Inhalation reference concentration	mg/m^3	Chemical specific

APPENDIX 6

DEVELOPMENT OF ALTERNATIVE REMEDIATION STANDARDS FOR SOIL FOR THE INGESTION-

DERMAL EXPOSURE PATHWAY

Pursuant to N.J.A.C. 7:26D-8.3(a)1i, an alternative remediation standard (ARS) for soil for the ingestion-dermal exposure pathway may be developed for a site or an area of concern in accordance with the procedures provided in this appendix.

I. Overview

(a) An ARS for this exposure pathway may be developed at any time. However, the need to develop an ARS shall not be a basis for extending an applicable mandatory timeframe, as set forth in the Administrative Requirements for the Remediation of Contaminated Sites, N.J.A.C. 7:26C.

(b) The ARS options listed in III(a) of this appendix are applicable to carcinogenic and noncarcinogenic health end-points.

(c) An ARS for this exposure pathway may be developed based on site-specific alternative land uses in accordance with III(a) and III(b)1 of this appendix.

(d) An ARS for this exposure pathway may be developed based on site-specific modification of parameters in accordance with III(b)2 and 3 of this appendix.

(e) An ARS for lead for this exposure pathway may be developed based on use of other models and methods pursuant to III(b)4 of this appendix.

II. Required Approvals and Permits

(a) An ARS developed in accordance with III(a) and III(b) of this appendix must be approved by the Department prior to use at the specific site or area of concern.

(b) The Department shall require the use of an institutional control, engineering control (as needed), and a remedial action permit, pursuant to N.J.A.C. 7:26C-7, for an ARS developed pursuant to III(a) and III(b)1 and 3 of this appendix to ensure that the continued use of the ARS remains valid.

(c) The Department shall not require the use of an institutional control, engineering control, and a remedial action permit, pursuant to N.J.A.C. 7:26C-7, for an ARS developed pursuant to III(b)2 of this appendix.

(d) Depending on the site-specific conditions the Department may require the use of an institutional control, engineering control, and a remedial action permit, pursuant to N.J.A.C. 7:26C-7, for an ARS developed pursuant to III(b)4 of this appendix.

III. Options and Procedures

(a) An ARS may be based on a site-specific alternative land use, which would involve an alternative exposure scenario (for example, exposure frequency and exposure duration) that is neither a residential nor a nonresidential land use scenario.

1. Examples of alternative land uses include, but are not limited to:

i. Active recreational land use, such as sports playing fields and playgrounds;

ii. Passive recreational land use, such as land and trails used for walking, cycling, and hunting;

iii. Restricted access areas, such as right-of-way areas used for the inspection and repair of utilities; and

iv. Infrequent access areas, such as ecological preservation and conservation areas.

2. The following actions shall be taken when developing an ARS pursuant to this appendix:

i. Determine the intended use of the site and the appropriate exposure frequency (EF) and exposure duration (ED) associated with the intended land use in accordance with Department guidance located on the Department's website;

ii. Use the EF and ED in the Department's calculator located on the Department's website to calculate an alternative ingestion-dermal remediation standard; and

iii. Provide the following information to the Department in addition to the applicable form found on the Department's website:

(1) The resultant ARS and the modified input parameters used in the Department's calculator;

(2) A description and basis of how the input parameters were selected; and

(3) A description of any institutional controls and engineering controls associated with the ARS.

(b) For lead contamination, an ARS for this exposure pathway can be developed as follows:

1. Alternative Land Use Scenarios

i. An ARS for lead for an alternative land use may be based on the assessment of non-continuous nonresidential exposures identified in the USEPA's Assessing Intermittent or Variable Exposures at Lead Sites (USEPA, 2003)[1]; and

ii. Prior to the development of an ARS under III(b) of this appendix, consultation with the Department shall be required in accordance with Department guidance.

2. Site-Specific Changes to Default Values – Residential Exposure Scenario

i. An ARS for lead for a residential scenario may be based on input parameters identified by the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) (USEPA, 1994)[2]; and

ii. Prior to the development of an ARS for lead under III(b) of this appendix, consultation with the Department shall be required in accordance with Department guidance.

3. Site-Specific Changes to Default Values – Nonresidential Exposure Scenario

i. An ARS for lead for a nonresidential scenario may be based on the input parameters identified in the document Recommendations of the Technical Review Workgroup (TRW) for Lead for an Interim Approach to Assessing Risk Associated with Adult Exposures to Lead in Soil (USEPA, 1996)[3]; and

ii. Prior to the development of an ARS under III(b) of this appendix, consultation with the Department shall be required in accordance with Department guidance.

4. Other models and methods

i. With prior approval by the Department, an ARS for lead may also be developed using scientific models and methods other than those described in III(b)2 or 3 above.

[1] USEPA. 2003. Assessing Intermittent or Variable Exposures at Lead Sites, Office of Solid Waste and Emergency Response, OSWER 9285.7-76.

[2] USEPA. 1994. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. Office of Solid Waste and Emergency response, Washington, DC. OSWER 9285.7-15-1.

[3] USEPA. 1996. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, USEPA Technical Workgroup for Lead. December 1996.

APPENDIX 7

DEVELOPMENT OF ALTERNATIVE REMEDIATION STANDARDS FOR SOIL FOR THE INHALATION EXPOSURE PATHWAY

Pursuant to N.J.A.C. 7:26D-8.3(a)1ii, an alternative remediation standard (ARS) for soil for the inhalation exposure pathway may be developed for a site or an area of concern in accordance with the procedures provided in this appendix.

I. Overview

(a) An ARS for this exposure pathway may be developed at any time. However, the need to develop an ARS shall not be a basis for extending an applicable mandatory timeframe, as set in the Administrative Requirements for the Remediation of Contaminated Sites, N.J.A.C. 7:26C.

(b) The ARS options listed in III of this appendix are applicable to carcinogenic and noncarcinogenic health end-points.

(c) The ARS options outlined in III of this appendix may be utilized for residential and nonresidential land use scenarios, as well as alternative land use scenarios described in III(a) of this appendix.

(d) An ARS for this exposure pathway may be developed based on modification of site-specific exposure parameters listed in III(b) of this appendix.

II. Required Approvals and Permits

(a) An ARS developed in accordance with III(a) of this appendix must be approved by the Department prior to use at the specific site or area of concern.

(b) An ARS developed in accordance with III(b) of this appendix does not require approval by the Department prior to use at the specific site or area of concern.

(c) The Department shall require the use of an institutional control, engineering control (as needed), and a remedial action permit, pursuant to N.J.A.C. 7:26C-7 for an ARS developed

pursuant to III(a), III(b)1iv, and III(b)3 of this appendix to ensure that the continued use of the ARS remains valid.

(d) The Department shall not require the use of an institutional control, engineering control (as needed), and a remedial action permit, pursuant to N.J.A.C. 7:26C-7 for an ARS developed pursuant to III(b)1v and III(b)2 of this appendix.

III. Options and Procedures

(a) An ARS for this exposure pathway may be based on a site-specific alternative land use, which would involve an alternative exposure scenario (for example, exposure frequency, exposure time, and exposure duration) that is neither a residential nor a nonresidential land use scenario.

1. Examples of alternative land uses include, but are not limited to:

i. Active recreational land use, such as sports playing fields and playgrounds;

ii. Passive recreational land use, such as land and trails used for walking, cycling, and hunting; and

iii. Access areas, such as right-of-way areas used for the inspection and repair of utilities.

2. The following actions shall be taken when developing an ARS pursuant to this appendix:

i. Determine the intended use of the site and the appropriate exposure frequency (EF), exposure time (ET), and exposure duration (ED) associated with the intended land use in accordance with Department guidance;

ii. Use the EF, ET, and ED in the Department's calculator located on the Department's website to calculate the ARS; and

iii. Submit the following information to the Department in addition to the applicable form found on the Department's website:

(1) The resultant ARS and the modified input parameters used in the Department's calculator;

(2) A description and basis of how the input parameters were selected; and

(3) A description of institutional controls and engineering controls associated with the ARS.

(b) An ARS for soil for this exposure pathway may be based site-specific parameter modifications as follows:

1. Depth Range of Contamination:

i. Determine the actual depth range of contamination by delineation sampling pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-4, and Department guidance;

ii. Use the actual depth range of contamination in the Department's calculator located on the Department's website to calculate an alternative inhalation remediation standard;

iii. Provide the following information to the Department in addition to the applicable form found on the Department's website with the applicable remedial phase report:

(1) The resultant ARS and the modified input parameters used in the Department's calculator;

(2) A description and basis of how the input parameters were selected, including all related laboratory results; and

(3) A description of any institutional controls and engineering controls associated with the ARS;

iv. The Department shall require the use of an institutional control, engineering control (as needed), and a remedial action permit, pursuant to N.J.A.C. 7:26C-7, for an ARS based on a site-specific depth range of contamination that begins at a depth greater than zero feet below ground surface to ensure that the continued use of the ARS remains valid; and

v. The Department shall not require the use of an institutional control, engineering control, or a remedial action permit, pursuant to N.J.A.C. 7:26C-7, for an ARS based on a site-specific depth range of contamination that begins at the ground surface.

2. Soil Organic Carbon Content (foc):

i. Collect and analyze samples for determining foc in accordance with the appropriate Department guidance;

ii. Input the appropriate foc value(s) in the Department's calculator located on the Department's website when calculating an alternative inhalation remediation standard; and

iii. Provide the following to the Department in addition to the applicable form found on the Department's website with the applicable remedial phase report:

(1) The resultant ARS and the modified input parameters used in the Department's calculator; and

(2) A description and basis of how the input parameters were selected, including all related laboratory results.

3. Fraction of Vegetative Cover (V):

i. Determine V on the site in accordance with the appropriate Department guidance;

ii. Use V in the Department's calculator located on the Department's website to calculate the ARS for soil for the inhalation exposure pathway; and

iii. Provide the following information to the Department in addition to the applicable form found on the Department's website with the applicable remedial phase report:

(1) The resultant ARS and the modified input parameters used in the Department's calculator;

(2) A description and basis of how the input parameters were selected, including all measurements and calculations; and

(3) A description of any institutional controls and engineering controls associated with the ARS.

APPENDIX 8

DEVELOPMENT OF ALTERNATIVE REMEDIATION STANDARDS FOR SOIL FOR THE MIGRATION TO GROUND WATER EXPOSURE PATHWAY

Pursuant to N.J.A.C. 7:26D-8.3(a)1iii, an alternative remediation standard (ARS) for soil for the migration to ground water exposure pathway may be developed for a site or an area of concern in accordance with the procedures provided in this appendix.

I. Overview

(a) An ARS for soil for this exposure pathway may be developed at any time. However, the need to develop an ARS shall not be a basis for extending an applicable mandatory timeframe, as set forth in the Administrative Requirements for the Remediation of Contaminated Sites, N.J.A.C. 7:26C.

(b) An ARS may be developed based on the site-specific options described in III of this appendix and submitted to the Department with the appropriate form(s).

II. Required Approvals and Permits

(a) An ARS developed in accordance with III(a), III(b), and III(c) of this appendix must be approved by the Department prior to use at the specific site or area of concern.

(b) An ARS developed in accordance with III(d), III(e), III(f), and III(g) of this appendix does not require approval by the Department prior to use at the specific site or area of concern.

(c) With prior approval by the Department, an ARS may also be developed using scientific methods other than those described in III(a) though (g) below including relevant guidance from the USEPA, other states, and other relevant, applicable, and appropriate methods and practices that ensure the protection of public health and safety and of the environment.

(d) With the exception noted in III(c) of this appendix, an ARS developed pursuant to this appendix does not require the use of an institutional control, engineering control, and a remedial action permit, pursuant to N.J.A.C. 7:26C-7.

III. Options and Procedures

(a) Determination of a site-specific Dilution-Attenuation Factor (DAF) as follows:

1. Measure the length of the area of concern parallel to the ground water flow, the aquifer hydraulic conductivity, the aquifer gradient and, if necessary, aquifer thickness in accordance with the appropriate Department guidance.

2. Input the appropriate values into the Department's calculators (DAF calculator or Soil-Water Partition Equation calculator) located on the Department's website.

3. Provide the following to the Department in addition to the applicable form found on the Department's website:

i. The resultant ARS and the modified input parameters used in the Department's DAF calculator or the Department's Soil-Water Partition Equation calculator; and

ii. Documentation of the determination and basis of the site-specific parameters used to determine the DAF including all related tables, figures, and laboratory results.

(b) Seasonal Soil Compartment Model (SESOIL) modeling as follows:

1. Delineate contamination and determine the depth to ground water in accordance with the appropriate Department guidance.

2. If desired, determine soil texture in accordance with the appropriate Department guidance.

3. If desired, determine soil organic carbon content according to III(d) of this appendix.

4. Input the appropriate parameters into the SESOIL model in accordance with the appropriate Department guidance.

5. Provide the following to the Department in addition to the applicable form found on the Department's website:

i. For each ARS determined using the SESOIL model, a SESOIL model table showing the measured contaminant concentrations as a function of depth and the modeled SESOIL concentrations, results from the most current version of the SEVIEW model software of the SESOIL CLIMATE report, the SESOIL HYDROLOGIC CYCLE report, the

SESOIL PROFILE AND LOAD REPORT, and the SESOIL POLLUTANT CYCLE report. The project file (*.prj file) from the SEVIEW project shall also be submitted; and

ii. A description and basis of how the SESOIL input parameters were determined, including all related tables, figures, and laboratory results.

6. An alternative software package equivalent to SEVIEW that has been authorized by the Department may be used as a substitute for SEVIEW in application of III(b) of this appendix.

(c) Seasonal Soil Compartment Model/Analytical Transient 1-,2-,3-Dimensional (SESOIL/AT123D) modeling as follows:

1. The SESOIL/AT123D model shall only be used when:

i. The contaminated ground water plume has been delineated in accordance with the Technical Requirements for Site Remediation, N.J.A.C. 7:26E and appropriate Department guidance;

ii. A Classification Exception Area (CEA) exists for contaminated ground water on the site; and

iii. An impermeable cap does not and will not exist above the vadose zone contamination. Any permeable cap used shall allow unrestricted ground water recharge.

2. Delineate the vadose zone contamination and determine the depth to ground water in accordance with the appropriate Department guidance.

3. Determine the soil organic carbon for both the vadose zone and the aquifer according to III(d) of this appendix.

4. Determine the soil texture for the vadose zone in accordance with the appropriate Department guidance.

5. If desired, determine the aquifer texture in accordance with the appropriate Department guidance.

6. Input the appropriate parameters into the SESOIL/AT123D model in accordance with the appropriate Department guidance.

7. Provide the following to the Department, in addition to the applicable form found on the Department's website:

i. For each ARS determined using the combined SESOIL/AT123D model, a SESOIL model table showing the measured vadose zone contaminant concentrations as a function of depth and the modeled SESOIL concentrations, a map of the delineated ground water plume (with concentration isopleths) showing AT123D ground water sources and the concentrations and dimensions used in the model for each source, the SEVIEW project map, results from the most current version of the SEVIEW model software of the SESOIL CLIMATE report, the SESOIL HYDROLOGIC CYCLE report, the SESOIL PROFILE AND LOAD REPORT, the SESOIL POLLUTANT CYCLE report, an AT123D Point of Compliance Report at the downgradient edge of the Area of Concern at the centerline of the plume at the surface of the water table, and an AT123D Point of Compliance Report at the

maximum extent of the plume at the centerline of the plume at the surface of the water table. For each AT123D Point of Compliance Report, the numerical concentration of the contaminant at the last time step (end of the CEA time period) shall be shown in an EXCEL window pasted on to the report. The project file (*.prj file) from the SEVIEW project shall also be submitted; and

ii. A description and basis of how the SESOIL/AT123D input parameters were determined, including all related tables, figures, and laboratory results.

8. Except for the existing CEA and the remedial action permit, the Department shall not require the use of any additional institutional control, engineering control, or a remedial action permit, pursuant to N.J.A.C. 7:26C-7 for an ARS based on site-specific SESOIL/AT123D modeling.

9. An alternative software package equivalent to SEVIEW that has been authorized by the Department may be used as a substitute for SEVIEW in application of III(c) of this appendix.

(d) A site-specific soil organic carbon content (foc) in the Soil Water Partition Equation, found at N.J.A.C. 7:2DC Appendix 4 as follows:

1. Collect and analyze samples for determining foc in accordance with the appropriate Department guidance.

2. Input the appropriate foc value(s) in the Department's foc calculator located on the Department's website to determine the site-specific foc value.

3. Input the site-specific foc value into the Soil-Water Partition Equation calculator located on the Department's website in order to determine the alternative remediation standard.

4. Provide the following to the Department in addition to the applicable form found on the Department's website with the applicable remedial phase report:

i. The resultant ARS and the modified input parameters used in the Department's foc and soil-water partition calculators; and

ii. A description and basis of how the soil organic carbon content was selected, including all related tables, figures, and laboratory results.

(e) The Synthetic Precipitation Leaching Procedure (SPLP) ARS options contained in technical guidance issued by the Department, except when combining with a site-specific DAF as provided in III(a) of this appendix. The procedure shall be as follows:

1. Collect samples and implement the SPLP procedure in accordance with the appropriate Department guidance.

2. Input the appropriate values into the Department's SPLP calculator located on the Department's website.

3. Provide the following to the Department in addition to the applicable form found on the Department's website with the applicable remedial phase report:

i. The resultant ARS and the modified input parameters used in the Department's SPLP calculator; and

ii. A description and basis of how the samples were selected, including all related laboratory results.

(f) Site-specific data for immobile contaminants only when:

1. The contaminant exhibits a very low mobility in soil as defined by a high soil organic carbon-water partition coefficient (Koc) or a high soil-water partition coefficient (Kd), factors that increase a contaminant's mobility are not present, and a clean zone of two feet or greater exists between the contamination and the water table, as described in appropriate Department guidance.

2. The procedure shall be as follows:

i. Collect and analyze soil samples in accordance with the appropriate Department guidance; and

ii. Provide a description and basis of how the samples were used to demonstrate compliance with the migration to ground water exposure pathway, including all related tables, figures, and laboratory results, to the Department, in addition to the applicable form found on the Department's website with the applicable remedial phase report.

3. If compliance with the migration to ground water exposure pathway is determined by the site-specific conditions in III(f)1 of this appendix only, then the numeric standards in this chapter shall not apply, but the pathway will be deemed to have been satisfactorily addressed on a narrative basis.

(g) Site-specific data for metals, semi-volatile contaminants, and volatile contaminants only when:

1. The highest concentrations of remaining contamination are located at the water table and no ground water impact above the ground water remediation standard is observed as demonstrated by ground water sampling, as described in appropriate Department guidance.

2. The procedure shall be as follows:

i. Collect and analyze soil and ground water samples in accordance with the appropriate Department guidance; and

ii. Provide a description and basis of how the samples were used to demonstrate compliance with the migration to ground water exposure pathway, including all related tables, figures, and laboratory results, to the Department in addition to the applicable form from the Department's website with the applicable remedial phase report.

3. If compliance with the migration to ground water exposure pathway is determined by the site-specific conditions in III(g) of this appendix only, then the numeric standards in this chapter shall not apply, but the pathway will be deemed to have been satisfactorily addressed on a narrative basis.

APPENDIX 9

DEVELOPMENT OF ALTERNATIVE REMEDIATION STANDARDS FOR INDOOR AIR FOR THE VAPOR INTRUSION EXPOSURE PATHWAY

Pursuant to N.J.A.C. 7:26D-8.3(a)2, an alternative remediation standard (ARS) for indoor air for the vapor intrusion exposure pathway may be developed for a site or an area of concern in accordance with the procedures provided in this appendix.

I. Overview

(a) An ARS for this exposure pathway may be developed at any time. However, the need to develop an ARS shall not be a basis for extending an applicable mandatory timeframe, as provided in the Administrative Requirements for the Remediation of Contaminated Sites, N.J.A.C. 7:26C.

(b) The ARS options listed in III of this appendix are applicable to carcinogenic and noncarcinogenic health end-points.

(c) The ARS options outlined in III of this appendix may be utilized for nonresidential buildings, but they are not applicable to residential buildings.

(d) An ARS may be developed based on modification of site-specific exposure parameters listed in III of this appendix.

II. Required Approvals and Permits

(a) An ARS developed in accordance with this appendix must be approved by the Department prior to use at the specific site or area of concern.

(b) The Department shall require the use of an institutional control, engineering control (as needed), and a remedial action permit, pursuant to N.J.A.C. 7:26C-7 for an ARS developed pursuant to this appendix to ensure that the continued use of the ARS remains valid.

III. Options and Procedures

(a) An ARS developed pursuant to this appendix is limited to site-specific modification of the following exposure parameters:

1. An alternative exposure frequency (EF) parameter representative of site-specific use that is incorporated in the applicable indoor air Equation 1 and 2 at N.J.A.C. 7:26D Appendix 5; or

2. An alternative exposure time (ET) parameter representative of site-specific use that is incorporated in the applicable indoor air Equation 1 and 2 at N.J.A.C. 7:26D Appendix 5.

(b) Examples where or when site-specific modification of exposure parameters may be acceptable include, but are not limited to:

1. A small generating station;

2. An isolated storage facility;

3. A restricted access area of a nonresidential building, such as a basement; or

4. Workday hours differing from eight hours.

(c) In developing an ARS pursuant to this appendix, the following supporting information, in addition to the applicable form found on the Department's website, shall be submitted to the Department:

1. The resultant ARS and the modified input parameters used in the Department's ARS calculator;

2. Support documentation justifying:

i. The basis for the site-specific parameters used to determine the ARS;

ii. The adequacy of proposed monitoring; and

iii. The adequacy of the institutional and engineering controls;

3. An overview of the history and contamination at the site or area of concern pertinent to the vapor intrusion exposure pathway including:

i. A description of any vapor intrusion investigation related to the ARS;

ii. The extent of soil and ground water contamination at the site affecting the vapor intrusion exposure pathway;

iii. A description of the subject building(s) and a scaled map of the site and surrounding area, identifying the subject building(s) and associated analytical results, including soil gas;

iv. Identification of the uses in the subject building(s) and the locations where receptors are present within the building(s);

v. A summary table presenting the analytical results, in accordance with N.J.A.C. 7:26E-1.6(b)6; and

4. Additional information used to develop the ARS.

APPENDIX 10

CHEMICAL AND PHYSICAL PROPERTIES OF CONTAMINANTS

Chemical and Physical Properties of Contaminants

Contaminant	CAS No.	Water Solubility (mg/L)	Henry's Law Constant (atm-m^3/mol, 25°C)	Henry's Law Constant (dimensionless, 25°C)	Air Diffusivity (cm^2/sec)	Water Diffusivity (cm^2/sec)	Soil Organic Carbon-Water Partition Coefficient, K_{oc} (L/kg)	Soil-Water Partition Coefficient, K_d (L/kg)
Acenaphthene	83-32-9	3.9	1.84E-04	7.5224E-03	5.0614E-02	8.3300E-06	5027	NA
Acetone (2-Propanone)	67-64-1	1000000	3.50E-05	1.4309E-03	1.0592E-01	1.1471E-05	2.364	NA
Acetophenone	98-86-2	6130	1.04E-05	4.2518E-04	6.5222E-02	8.7228E-06	51.85	NA
Aldrin	309-00-2	0.017	4.40E-05	1.7989E-03	2.2812E-02	5.8402E-06	82020	NA
Aluminum (total)	7429-90-5	NA	NA	NA	NA	NA	NA	1500
Anthracene	120-12-7	0.0434	5.56E-05	2.2731E-03	3.8973E-02	7.8522E-06	16360	NA
Antimony (total)	7440-36-0	NA	NA	NA	NA	NA	NA	45
Arsenic (total)	7440-38-2	NA	NA	NA	NA	NA	NA	26[1]
Atrazine	1912-24-9	34.7	2.36E-09	9.6484E-08	2.6466E-02	6.8378E-06	224.5	NA
Barium (total)	7440-39-3	NA	NA	NA	NA	NA	NA	17[1]
Benzaldehyde	100-52-7	6950	2.67E-05	1.0916E-03	7.4393E-02	9.4627E-06	11.09	NA
Benzene	71-43-2	1790	5.55E-03	2.2690E-01	8.9534E-02	1.0263E-05	145.8	NA
Benzo(a)anthracene (1,2-Benzanthracene)	56-55-3	0.0094	1.20E-05	4.9059E-04	2.6144E-02	6.7495E-06	176900	NA
Benzo(a)pyrene	50-32-8	0.00162	4.57E-07	1.8683E-05	4.7583E-02	5.5597E-06	587400	NA
Benzo(b)fluoranthene (3,4-Benzofluoranthene)	205-99-2	0.0015	6.57E-07	2.6860E-05	4.7583E-02	5.5597E-06	599400	NA
Benzo(k)fluoranthene	207-08-9	0.0008	5.84E-07	2.3875E-05	4.7583E-02	5.5597E-06	587400	NA
Beryllium	7440-41-7	NA	NA	NA	NA	NA	NA	35[1]
1,1'-Biphenyl	92-52-4	7.48	3.08E-04	1.2592E-02	4.7059E-02	7.5618E-06	5129	NA

Bis(2-chloroethoxy)methane	111-91-1	7800	3.85E-06	1.5740E-04	6.1186E-02	7.1492E-06	14.38	NA
Bis(2-chloroethyl)ether	111-44-4	17200	1.70E-05	6.9501E-04	5.6719E-02	8.7070E-06	32.21	NA
Bis(2-ethylhexyl)phthalate	117-81-7	0.27	2.70E-07	1.1038E-05	1.7340E-02	4.1807E-06	119600	NA
Bromodichloromethane (Dichlorobromomethane)	75-27-4	3032	2.12E-03	8.6672E-02	5.6263E-02	1.0731E-05	31.82	NA
Bromoform	75-25-2	3100	5.35E-04	2.1872E-02	3.5732E-02	1.0356E-05	31.82	NA
Bromomethane (Methyl bromide)	74-83-9	15200	7.34E-03	3.0008E-01	1.0050E-01	1.3468E-05	13.22	NA
2-Butanone (Methyl ethyl ketone) (MEK)	78-93-3	223000	5.69E-05	2.3262E-03	9.1446E-02	1.0193E-05	4.51	NA
Butylbenzyl phthalate	85-68-7	2.69	1.26E-06	5.1513E-05	2.0832E-02	5.1733E-06	7155	NA
Cadmium	7440-43-9	NA	NA	NA	NA	NA	NA	23[1]
Caprolactam	105-60-2	772000	2.53E-08	1.0343E-06	6.9242E-02	8.9994E-06	24.5	NA
Carbon disulfide	75-15-0	2160	1.44E-02	5.8872E-01	1.0644E-01	1.2977E-05	21.73	NA
Carbon tetrachloride	56-23-5	793	2.76E-02	1.1284E+00	5.7143E-02	9.7849E-06	43.89	NA
Chlordane (alpha and gamma forms summed)	57-74-9	0.056[2]	4.86E-05[2]	1.9869E-03[2]	1.7900E-02[3]	4.3700E-06[3]	67540[5]	NA
4-Chloroaniline	106-47-8	3900	1.16E-06	4.7424E-05	7.0385E-02	1.0253E-05	112.7	NA
Chlorobenzene	108-90-7	498	3.11E-03	1.2715E-01	7.2130E-02	9.4765E-06	233.9	NA
Chloroethane (Ethyl chloride)	75-00-3	6710	1.11E-02	4.5380E-01	1.0376E-01	1.1619E-05	21.73	NA
Chloroform	67-66-3	7950	3.67E-03	1.5004E-01	7.6920E-02	1.0891E-05	31.82	NA
Chloromethane (Methyl chloride)	74-87-3	5320	8.82E-03	3.6059E-01	1.2396E-01	1.3648E-05	13.22	NA
2-Chloronaphthalene	91-58-7	11.7	3.20E-04	1.3082E-02	4.4691E-02	7.7301E-06	2478	NA
2-Chlorophenol (o-Chlorophenol)	95-57-8	11300	1.12E-05	4.57890E-04	6.6118E-02	9.4784E-06	398[1]	NA
Chrysene	218-01-9	0.002	5.23E-06	2.1382E-04	2.6114E-02	6.7495E-06	180500	NA
Cobalt (total)	7440-48-4	NA	NA	NA	NA	NA	NA	45
Copper (total)	7440-50-8	NA	NA	NA	NA	NA	NA	35
Cyanide	57-12-5	NA	NA	NA	NA	NA	NA	9.9
Cyclohexane	110-82-7	55	1.50E-01	6.1325E+00	7.9973E-02	9.1077E-06	145.8	NA
4,4'-DDD (p,p'-TDE)	72-54-8	0.09	6.60E-06	2.6983E-04	4.0608E-02	4.7447E-06	117500	NA
4,4'-DDE (p,p'-DDX)	72-55-9	0.04	4.16E-05	1.7007E-03	2.3000E-02	5.8592E-06	117500	NA
4,4'-DDT	50-29-3	0.0055	8.32E-06	3.4015E-04	3.7933E-02	4.4322E-06	168600	NA
Dibenz(a,h)anthracene	53-70-3	0.00249	1.41E-07	5.7645E-06	4.4567E-02	5.2073E-06	1912000	NA
Dibromochloromethane (Chlorodibromomethane)	124-48-1	2700	7.83E-04	3.2011E-02	3.6636E-02	1.0561E-05	31.82	NA
1,2-Dibromo-3-chloropropane	96-12-8	1230	1.47E-04	6.0098E-03	3.2135E-02	8.9048E-06	115.8	NA
1,2-Dibromoethane (Ethylene dibromide)	106-93-4	3910	6.50E-04	2.6574E-02	4.3035E-02	1.0439E-05	39.6	NA
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	156	1.92E-03	7.8496E-02	5.6170E-02	8.9213E-06	382.9	NA
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	125[2]	2.63E-03[2]	1.0751E-01[2]	6.9200E-02[4]	7.8600E-06[4]	375.3[5]	NA
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	81.3	2.41E-03	9.8528E-02	5.5043E-02	8.6797E-06	375.3	NA

3,3'-Dichlorobenzidine	91-94-1	3.1	2.84E-11	1.1611E-09	4.7482E-02	5.5478E-06	3190	NA
Dichlorodifluoromethane (Freon 12)	75-71-8	280	3.43E-01	1.4023E+01	7.6029E-02	1.0839E-05	43.89	NA
1,1-Dichloroethane	75-34-3	5040	5.62E-03	2.2976E-01	8.3645E-02	1.0621E-05	31.82	NA
1,2-Dichloroethane	107-06-2	8600	1.18E-03	4.8242E-02	8.5722E-02	1.0995E-05	39.6	NA
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	2420	2.61E-02	1.0670E+00	8.6311E-02	1.0956E-05	31.82	NA
1,2-Dichloroethene (cis) (c-1,2-Dichloroethylene)	156-59-2	6410	4.08E-03	1.6680E-01	8.8406E-02	1.1335E-05	39.6	NA
1,2-Dichloroethene (trans) (t-1,2-Dichloroethylene)	156-60-5	4520	9.38E-03	3.8348E-01	8.7609E-02	1.1191E-05	39.6	NA
2,4-Dichlorophenol	120-83-2	5500	4.29E-06	1.7538E-04	4.8577E-02	8.6786E-06	159[1]	NA
1,2-Dichloropropane	78-87-5	2800	2.82E-03	1.1529E-01	7.3340E-02	9.7252E-06	60.7	NA
1,3-Dichloropropene (total)	542-75-6	2800	3.55E-03	1.4513E-01	7.6272E-02	1.0123E-05	72.17	NA
Dieldrin	60-57-1	0.195	1.00E-05	4.0883E-04	2.3286E-02	6.0062E-06	20090	NA
Diethylphthalate	84-66-2	1080	6.10E-07	2.4939E-05	2.6074E-02	6.7227E-06	104.9	NA
2,4-Dimethylphenol	105-67-9	7870	9.51E-07	3.8879E-05	6.2245E-02	8.3140E-06	491.8	NA
Di-n-butyl phthalate	84-74-2	11.2	1.81E-06	7.3998E-05	2.1436E-02	5.3255E-06	1157	NA
2,4-Dinitrophenol	51-28-5	2790	8.60E-08	3.5159E-06	4.06670E-02	9.0756E-06	0.0178[1]	NA
2,4-Dinitrotoluene/2,6-Dinitrotoluene (mixture)	25321-14-6	270	3.97E-07	1.6230E-05	5.9131E-02	6.9090E-06	587.4	NA
Di-n-octyl phthalate	117-84-0	0.022	2.57E-06	1.0506E-04	3.5559E-02	4.1548E-06	140800.00	NA
1,4-Dioxane	123-91-1	1000000	4.80E-06	1.9624E-04	8.7374E-02	1.0541E-05	2.633	NA
Endosulfan I and Endosulfan II (alpha and beta) (summed)	115-29-7	0.325	6.50E-05	2.6574E-03	2.2484E-02	5.7628E-06	6761	NA
Endrin	72-20-8	0.25	6.36E-06	2.600E-04	3.6158E-02	4.2248E-06	20090	NA
Ethylbenzene	100-41-4	169	7.88E-03	3.2216E-01	6.8465E-02	8.4558E-06	446.1	NA
Extractable Petroleum Hydrocarbons (Category 1)	various	NA	NA	NA	NA	NA	NA	NA
Extractable Petroleum Hydrocarbons (Category 2)	various	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	206-44-0	0.26	8.86E-06	3.6222E-04	2.7596E-02	7.1827E-06	55450	NA
Fluorene	86-73-7	1.69	9.62E-05	3.9329E-03	4.3974E-02	7.8890E-06	9160	NA
alpha-HCH (alpha-BHC)	319-84-6	2	6.70E-06	2.7392E-04	4.3284E-02	5.0574E-06	2807	NA
beta-HCH (beta-BHC)	319-85-7	0.24	4.40E-06	1.7988E-05	2.7667E-02	7.3955E-06	2807	NA
Heptachlor	76-44-8	0.18	2.94E-04	1.2020E-02	2.2344E-02	5.6959E-06	41260	NA
Heptachlor epoxide	1024-57-3	0.2	2.10E-05	8.5854E-04	2.4001E-02	6.2475E-06	10110	NA
Hexachlorobenzene	118-74-1	0.0062	1.70E-03	6.9501E-02	2.8974E-02	7.8497E-06	6195	NA
Hexachloro-1,3-butadiene	87-68-3	3.2	1.03E-02	4.2110E-01	2.6744E-02	7.0264E-06	845.2	NA
Hexachlorocyclopentadiene	77-47-4	1.8	2.70E-02	1.1038E+00	2.7238E-02	7.2170E-06	1404	NA
Hexachloroethane	67-72-1	50	3.89E-03	1.5904E-01	3.2094E-02	8.8904E-06	196.8	NA
n-Hexane	110-54-3	9.5	1.80E+00	7.3590E+01	7.3108E-02	8.1658E-06	131.5	NA
2-Hexanone	591-78-6	17200	9.32E-05	3.8103E-03	7.0356E-02	8.4404E-06	14.98	NA
Indeno(1,2,3-cd)pyrene	193-39-5	0.00019	3.48E-07	1.4227E-05	4.4784E-02	5.2327E-06	1951000	NA

Isophorone	**78-59-1**	**12000**	**6.64E-06**	**2.7146E-04**	**5.2505E-02**	**7.5296E-06**	**65.15**	**NA**
Isopropylbenzene	**98-82-8**	**61.3**	**1.15E-02**	**4.7016E-01**	**6.0304E-02**	**7.8566E-06**	**697.8**	**NA**
Lead (total)	**7439-92-1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**900**
Lindane (gamma-HCH) (gamma-BHC)	**58-89-9**	**7.3**	**5.14E-06**	**2.1014E-04**	**4.3284E-02**	**5.0574E-06**	**2807**	**NA**
Manganese (total)	**7439-96-5**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**65**
Mercury (total)	**7439-97-6**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.20[1]**
Methoxychlor	**72-43-5**	**0.1**	**2.03E-07**	**8.2993E-06**	**2.2085E-02**	**5.5926E-06**	**26890**	**NA**
Methyl acetate	**79-20-9**	**243000**	**1.15E-04**	**4.7016E-03**	**9.5776E-02**	**1.1008E-05**	**3.064**	**NA**
Methylene chloride (Dichloromethane)	**75-09-2**	**13000**	**3.25E-03**	**1.3287E-01**	**9.9936E-02**	**1.2512E-05**	**21.73**	**NA**
2-Methylnaphthalene	**91-57-6**	**24.6**	**5.18E-04**	**2.1177E-02**	**5.2432E-02**	**7.7811E-06**	**2478**	**NA**
4-Methyl-2-pentanone (MIBK)	**108-10-1**	**19000**	**1.38E-04**	**5.6419E-03**	**6.9780E-02**	**8.3477E-06**	**12.6**	**NA**
2-Methylphenol (o-cresol)	**95-48-7**	**25900**	**1.20E-06**	**4.9060E-05**	**7.2835E-02**	**9.3168E-06**	**306.5**	**NA**
4-Methylphenol (p-cresol)	**106-44-5**	**21500**	**1.00E-06**	**4.0883E-05**	**7.2394E-02**	**9.2397E-06**	**300.4**	**NA**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**51000**	**5.87E-04**	**2.3998E-02**	**7.5267E-02**	**8.5904E-06**	**11.56**	**NA**
Naphthalene	**91-20-3**	**31**	**4.40E-04**	**1.7988E-02**	**6.0499E-02**	**8.3770E-06**	**1544**	**NA**
Nickel (total)	**7440-02-0**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**24[1]**
4-Nitroaniline	**100-01-6**	**728**	**1.26E-09**	**5.153E-08**	**6.3660E-02**	**9.7545E-06**	**109.1**	**NA**
Nitrobenzene	**98-95-3**	**2090**	**2.40E-05**	**9.8119E-04**	**6.8054E-02**	**9.4494E-06**	**226.4**	**NA**
N-Nitrosodi-n-propylamine	**621-64-7**	**13000**	**5.38E-06**	**2.1995E-04**	**5.6440E-02**	**7.7580E-06**	**275.4**	**NA**
N-Nitrosodiphenylamine	**86-30-6**	**35**	**1.21E-06**	**4.9648E-05**	**5.5886E-02**	**6.5299E-06**	**2632**	**NA**
2,2'-oxybis (1-chloropropane)	**108-60-1**	**1700**	**7.42E-05**	**3.0335E-03**	**3.9889E-02**	**7.3606E-06**	**82.92**	**NA**
Pentachlorophenol	**87-86-5**	**14**	**2.45E-08**	**1.0016E-06**	**2.9520E-02**	**8.0121E-06**	**5100[1]**	**NA**
Phenol	**108-95-2**	**82800**	**3.33E-07**	**1.3614E-05**	**8.3398E-02**	**1.0254E-05**	**187.2**	**NA**
Polychlorinated biphenyls (PCBs)	**1336-36-3**	**0.7**	**4.15E-04**	**1.6966E-02**	**2.4340E-02**	**6.2671E-06**	**78100**	**NA**
Pyrene	**129-00-0**	**0.135**	**1.19E-05**	**4.8651E-04**	**2.7787E-02**	**7.2479E-06**	**54340**	**NA**
Selenium (total)	**7782-49-2**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**14[1]**
Silver (total)	**7440-22-4**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.26[1]**
Styrene	**100-42-5**	**310**	**2.75E-03**	**1.1243E-01**	**7.1114E-02**	**8.7838E-06**	**446.1**	**NA**
Tertiary butyl alcohol (TBA)	**75-65-0**	**1000000[2]**	**9.05E-06[2]**	**3.6996E-04[2]**	**9.8500E-02[3]**	**1.1400E-05[3]**	**2.111[5]**	**NA**
1,2,4,5-Tetrachlorobenzene	**95-94-3**	**0.595**	**1.00E-03**	**4.0883E-02**	**3.1896E-02**	**8.7531E-06**	**2220**	**NA**
2,3,7,8-Tetrachlorodibenzo-p-dioxin	**1746-01-6**	**0.0002**	**5.00E-05**	**2.0442E-03**	**4.7028E-02**	**6.7568E-06**	**249100**	**NA**
1,1,2,2-Tetrachloroethane	**79-34-5**	**2830**	**3.67E-04**	**1.5004E-02**	**4.8921E-02**	**9.2902E-06**	**94.94**	**NA**
Tetrachloroethene (PCE) (Tetrachloroethylene)	**127-18-4**	**206**	**1.77E-02**	**7.2363E-01**	**5.0466E-02**	**9.4551E-06**	**94.94**	**NA**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**23**	**8.84E-06**	**3.6140E-04**	**5.0338E-02**	**5.8816E-06**	**2969[1]**	**NA**
Toluene	**108-88-3**	**526**	**6.64E-03**	**2.7146E-01**	**7.7804E-02**	**9.2043E-06**	**233.9**	**NA**
Toxaphene	**8001-35-2**	**0.55**	**6.00E-06**	**2.4530E-04**	**3.2439E-02**	**3.7902E-06**	**77200**	**NA**

1,2,4-Trichlorobenzene	120-82-1	49	1.42E-03	5.8054E-02	3.9599E-02	8.4033E-06	1356	NA
1,1,1-Trichloroethane	71-55-6	1290	1.72E-02	7.0319E-01	6.4817E-02	9.5990E-06	43.89	NA
1,1,2-Trichloroethane	79-00-5	4590	8.24E-04	3.3688E-02	6.6890E-02	1.0026E-05	60.7	NA
Trichloroethene (TCE) (Trichloroethylene)	79-01-6	1280	9.85E-03	4.0270E-01	6.8662E-02	1.0221E-05	60.7	NA
Trichlorofluoromethane (Freon 11)	75-69-4	1100	9.70E-02	3.9657E+00	6.5356E-02	1.0048E-05	43.89	NA
2,4,5-Trichlorophenol	95-95-4	1200	1.62E-06	6.6230E-05	3.1394E-02	8.0893E-06	3140[1]	NA
2,4,6-Trichlorophenol	88-06-2	800	2.60E-06	1.0630E-04	3.1395E-02	8.0896E-06	999[1]	NA
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon TF)	76-13-1	170	5.26E-01	2.1504E+01	3.7566E-02	8.5920E-06	196.8	NA
1,2,4-Trimethylbenzene	95-63-6	57	6.16E-03	2.5184E-01	6.0675E-02	7.9208E-06	614.3	NA
Vanadium (total)	7440-62-2	NA	NA	NA	NA	NA	NA	1000
Vinyl chloride	75-01-4	8800	2.78E-02	1.1365E+00	1.0712E-01	1.2004E-05	21.73	NA
Xylenes (total)	1330-20-7	106	6.63E-03	2.7105E-01	6.8515E-02	8.4640E-06	382.9	NA
Zinc (total)	7440-66-6	NA	NA	NA	NA	NA	NA	23[1]

NA = Not applicable

All values from USEPA Regional Screening Level Tables (http://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables, referenced May 2018), unless otherwise indicated. This website only posts the USEPA's most recent tables. Past tables may be obtained by contacting the USEPA.

[1] Kd or Koc value listed for pH 5.3 in Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, United States Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC, December 2002 (http://www.epa.gov/superfund/superfund-soil-screening-guidance)

[2] Experimental values from the USEPA's Estimation Program Interface Suite, V 4.11 (https://www.eregional screening Tablepa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface)

[3] Calculated using the USEPA's WATER9 calculator, V 3.0.

(https://www3.epa.gov/ttn/chief/software/water/index.html)

[4] From the USEPA's WATER9 calculator, V 3.0 database

(https://www3.epa.gov/ttn/chief/software/water/index.html)

[5] Molecular Connectivity Index values from USEPA's Estimation Program Interface Suite, V 4.11 (https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface)

APPENDIX 11

TOXICITY FACTORS USED IN THE DEVELOPMENT OF THE REMEDIATION STANDARDS

Table 1 – Soil Ingestion-Dermal Toxicity Factors

Contaminant	CAS No.	Soil Ingestion-dermal Recommendation	Soil Ingestion-dermal Toxicity Factor(s)
Acenaphthene	83-32-9	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1994) 0.06 mg/kg-day ABS 0.13
Acetone	67-64-1	IRIS RfD	IRIS RfD (2003) 0.9 mg/kg-day
Acetophenone	98-86-2	IRIS RfD	IRIS RfD (1989) 0.1 mg/kg-day
Aldrin	309-00-2	IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) RfD with a dermal absorption fraction (ABS)	IRIS SF (1993) 17 (mg/kg-day)-1 IRIS RfD (1988) 0.00003 mg/kg-day ABS 0.1
Aluminum	7429-90-5	PPRTV RfD	PPRTV RfD (2006) 1.0 mg/kg-day
Anthracene	120-12-7	IRIS RfD with a dermal absorption fraction (ABS)	IRIS RfD (1993) 0.3 mg/kg-day ABS 0.13

Antimony	**7440-36-0**	**IRIS RfD with a gastrointestinal absorption fraction (GIABS)**	**IRIS RfD (1991) 0.0004 mg/kg-day GIABS 0.15**
Arsenic	**7440-38-2**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1998) 1.5 (mg/kg-day)-1 IRIS RfD (1993) 0.0003 mg/kg-day ABS 0.03**
Atrazine	**1912-24-9**	**IRIS RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor**	**IRIS RfD (1993) 0.035 mg/kg-day ABS 0.1 Group C carcinogen factor 10**
Barium	**7440-39-3**	**IRIS RfD with a gastrointestinal absorption fraction (GIABS)**	**IRIS RfD (2005) 0.2 mg/kg-day GIABS 0.07**
Benzaldehyde	**100-52-7**	**PPRTV Slope Factor (SF) IRIS RfD**	**PPRTV SF (2015 4E-03 (mg/kg-day)-1 IRIS RfD (1988) 0.1 mg/kg-day**
Benzene	**71-43-2**	**NJDWQI Slope Factor (SF) IRIS RfD[1]**	**NJDWQI SF (1994) 0.23 (mg/kg-day)-1 IRIS RfD (2003) 0.004 mg/kg-day**
Benzo(a)anthracene	**56-55-3**	**IRIS Slope Factor (SF)(benzo(a)pyrene - adjusted for benzo(a)pyrene) with a dermal absorption fraction (ABS)**	**IRIS SF (2017) 1.0E-01(mg/kg-day)-1 (adjusted for benzo(a)anthracene) ABS 0.13**
Benzo(a)pyrene	**50-32-8**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (2017) 1.0E+00 (mg/kg-day)-1 IRIS RfD (2017) 3.0E-4 mg/kg-day ABS 0.13**
Benzo(b)fluoranthene	**205-99-2**	**IRIS Slope Factor (SF)(benzo(a)pyrene - adjusted for benzo(b)fluoranthene) with a dermal absorption fraction (ABS)**	**IRIS SF (2017) 1.0E-01 (mg/kg-day)-1 (adjusted for benzo(b)fluoranthene) ABS 0.13**

Benzo(k)fluoranthene	**207-08-9**	**IRIS Slope Factor (SF)(benzo(a)pyrene - adjusted for benzo(k)fluoranthene) with a dermal absorption fraction (ABS)**	**IRIS SF (2017) 1.0E-02(mg/kg-day)-1 (adjusted for benzo(k)fluoranthene) ABS 0.13**
Beryllium	**7440-41-7**	**IRIS RfD with a gastrointestinal absorption fraction (GIABS)**	**IRIS RfD (1998) 0.002 mg/kg-day GIABS 0.007**
1,1'-Biphenyl	**92-52-4**	**IRIS Slope Factor (SF) IRIS RfD**	**IRIS SF (2013) 0.008 (mg/kg-day)-1 IRIS RfD (2013) 0.5 mg/kg-day**
Bis(2-chloroethoxy) methane	**111-91-1**	**PPRTV RfD with a dermal absorption fraction (ABS)**	**PPRTV RfD (2006) 0.003 mg/kg-day ABS 0.1**
Bis(2-chloroethyl) ether	**111-44-4**	**IRIS Slope Factor (SF)**	**IRIS SF (1994) 1.1 (mg/kg-day)-1**
Bis(2-ethylhexyl) phthalate	**117-81-7**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1993) 0.014 (mg/kg-day)-1 IRIS RfD (2013) 0.02 mg/kg-day ABS 0.1**
Bromodichloromethane	**75-27-4**	**IRIS Slope Factor (SF) IRIS RfD**	**IRIS SF (1993) 0.062 (mg/kg-day)-1 IRIS RfD (1991) 0.02 mg/kg-day**
Bromoform	**75-25-2**	**IRIS Slope Factor (SF) IRIS RfD**	**IRIS SF (1991) 0.0079 (mg/kg-day)-1 IRIS RfD (1991) 0.02 mg/kg-day**
Bromomethane	**74-83-9**	**IRIS RfD**	**IRIS RfD (1991) 0.0014 mg/kg-day**
2-Butanone	**78-93-3**	**IRIS RfD[2]**	**IRIS RfD (2003) 0.6 mg/kg-day**
Butylbenzylphthalate	**85-68-7**	**PPRTV Slope Factor (SF) with a dermal absorption fraction (ABS). IRIS RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor**	**PPRTV SF (2002) 0.0019 (mg/kg-day)-1 IRIS RfD (2013) 0.2 mg/kg-day ABS 0.1 Group C carcinogen factor 10**
Cadmium	**7440-43-9**	**IRIS RfD with a dermal absorption fraction (ABS) and gastrointestinal absorption fraction (GIABS)**	**IRIS RfD (1994) 0.001 mg/kg-day ABS 0.001 GIABS 0.025**

Caprolactam	**105-60-2**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1988) 0.5 mg/kg-day ABS 0.1**
Carbon disulfide	**75-15-0**	**No ingestion-based toxicity factors are available**	**None**
Carbon tetrachloride	**56-23-5**	**NJDWQI Slope Factor (SF) IRIS RfD.**	**NJDWQI SF (1994) 0.091 (mg/kg-day)-1 IRIS RfD (2011) 0.004 mg/kg-day**
Chlordane (alpha plus gamma mixture)	**57-74-9**	**NJDWQI Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**NJDWQI SF (2001) 2.3 (mg/kg-day)-1 IRIS RfD (1998) 0.0005 mg/kg-day ABS 0.04**
4-Chloroaniline	**106-47-8**	**PPRTV Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**PPRTV SF (2008) 0.2 (mg/kg-day)-1 IRIS RfD (1995) 0.004 mg/kg-day ABS 0.1**
Chlorobenzene	**108-90-7**	**NJDWQI RfD**	**NJDWQI RfD (1994) 0.0065 mg/kg-day**
Chloroethane	**75-00-3**	**No ingestion-based toxicity factors are available**	**None**
Chloroform	**67-66-3**	**IRIS RfD[3]**	**IRIS RfD (2001) 0.01 mg/kg-day**
Chloromethane	**74-87-3**	**No ingestion-based toxicity factors are available**	**None**
2-Chloronaphthalene	**91-58-7**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1990) 0.08 mg/kg-day ABS 0.13**
2-Chlorophenol	**95-57-8**	**IRIS RfD**	**IRIS RfD (1993) 0.005 mg/kg-day**
Chrysene	**218-01-9**	**IRIS Slope Factor (SF) (benzo(a)pyrene – adjusted for chrysene) with a dermal absorption fraction (ABS)**	**IRIS SF (2017) 1.0E-03 (mg/kg-day)-1 (adjusted for chrysene) ABS 0.13**
Cobalt	**7440-48-4**	**PPRTV RfD**	**PPRTV RfD (2008) 0.0003 mg/kg-day**
Copper	**7440-50-8**	**HEAST RfD**	**HEAST RfD (1997) 0.04 mg/kg-day**
Cyanide	**57-12-5**	**IRIS RfD**	**IRIS RfD (2010) 0.0006 mg/kg-day**
Cyclohexane	**110-82-7**	**No ingestion-based toxicity factors are available**	**None**
4,4'-DDD	**72-54-8**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)**	**IRIS SF (1988) 0.24 (mg/kg-day)-1 ABS 0.1**

4,4'-DDE	**72-55-9**	**IRIS SF with a dermal absorption fraction (ABS)**	**IRIS SF (1988) 0.34 (mg/kg-day)-1 ABS 0.1**
4,4'-DDT	**50-29-3**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1991) 0.34 (mg/kg-day)-1 IRIS RfD (1996) 0.0005 mg/kg-day ABS 0.03**
Dibenz(a,h)anthracene	**53-70-3**	**IRIS Slope Factor (SF) (benzo(a)pyrene – adjusted for dibenz(a,h)anthracene) with a dermal absorption fraction (ABS)**	**IRIS SF (2017) 1.0E+00 (mg/kg-day)-1 (adjusted for dibenz(a,h)anthracene) ABS 0.13**
Dibromochloromethane	**124-48-1**	**IRIS Slope Factor (SF) IRIS RfD and a Group C carcinogen factor**	**IRIS SF (1992) 0.084 (mg/kg-day)-1 IRIS RfD (1991) 0.02 mg/kg-day Group C carcinogen factor**
1,2-Dibromo-3-chloropropane	**96-12-8**	**PPRTV Slope Factor (SF) PPRTV RfD**	**PPRTV SF (2006) 0.8 (mg/kg-day)-1 PPRTV RfD (2006) 0.0002 mg/kg-day**
1,2-Dibromoethane	**106-93-4**	**IRIS Slope Factor (SF) IRIS RfD**	**IRIS SF (2004) 2.0 (mg/kg-day)-1 IRIS RfD (2004) 0.009 mg/kg-day**
1,2-Dichlorobenzene	**95-50-1**	**NJDWQI RfD**	**NJDWQI RfD (1994) 0.086 mg/kg-day**
1,3-Dichlorobenzene	**541-73-1**	**NJDWQI RfD**	**NJDWQI RfD (1994) 0.086 mg/kg-day**
1,4-Dichlorobenzene	**106-46-7**	**NJDWQI RfD with a Group C carcinogen factor[4]**	**NJDWQI RfD (1994) 0.01 mg/kg-day (RfD includes Group C Carcinogen factor adjustment of 10)**
3,3'-Dichlorobenzidine	**91-94-1**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)**	**IRIS SF (1993) 0.45 (mg/kg-day)-1 ABS 0.1**
Dichlorodifluoromethane	**75-71-8**	**IRIS RfD**	**IRIS RfD (1995) 0.2 mg/kg-day**
1,1-Dichloroethane	**75-34-3**	**CalEPA Slope Factor (SF) PPRTV RfD[5]**	**CalEPA SF (1992) 0.0057 (mg/kg-day)-1 PPRTV RfD (2006) 0.2 mg/kg-day**
1,2-Dichloroethane	**107-06-2**	**NJDWQI Slope Factor (SF)[6]**	**NJDWQI SF (1994) 0.12 (mg/kg-day)-1**
1,1-Dichloroethene	**75-35-4**	**NJDWQI RfD with a Group C carcinogen factor**	**NJDWQI RfD (1994) 0.00014 mg/kg-day**

			(RfD includes Group C Carcinogen factor adjustment of 10)
cis-1,2-Dichloroethene	**156-59-2**	**NJDWQI RfD**	**NJDWQI RfD (1994) 0.01 mg/kg-day**
trans-1,2-Dichloroethene	**156-60-5**	**NJDWQI RfD**	**NJDWQI RfD (1994) 0.017 mg/kg-day**
2,4-Dichlorophenol	**120-83-2**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1988) 0.003 mg/kg-day ABS 0.1**
1,2-Dichloropropane	**78-87-5**	**PPRTV Slope Factor (SF) PPRTV RfD**	**PPRTV SF (2016) 0.037 (mg/kg-day)-1 PPRTV RfD (2016) 0.04 mg/kg-day**
1,3-Dichloropropene (cis and trans)	**542-75-6**	**IRIS Slope Factor (SF) IRIS RfD**	**IRIS SF (2000) 0.1 (mg/kg-day)-1 IRIS RfD (2000) 0.03 mg/kg-day**
Dieldrin	**60-57-1**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1993) 16 (mg/kg-day)-1 IRIS RfD (1990) 0.00005 mg/kg-day ABS 0.1**
Diethylphthalate	**84-66-2**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1993) 0.8 mg/kg-day ABS 0.1**
2,4-Dimethylphenol	**105-67-9**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1990) 0.02 mg/kg-day ABS 0.1**
Di-n-butylphthalate	**84-74-2**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1990) 0.1 mg/kg-day ABS 0.1**
2,4-Dinitrophenol	**51-28-5**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1991) 0.002 mg/kg-day ABS 0.1**
2,4-Dinitrotoluene /2,6-Dinitrotoluene (mixture)	**25321-14-6**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)**	**IRIS SF (1990) 0.68 (mg/kg-day)-1 ABS 0.1**
Di-n-octylphthalate	**117-84-0**	**PPRTV RfD with a dermal absorption fraction (ABS)**	**PPRTV RfD (2012) 0.01 mg/kg-day ABS 0.1**
1,4-Dioxane	**123-91-1**	**IRIS Slope Factor (SF) IRIS RfD**	**IRIS SF (2013) 0.1 (mg/kg-day)-1 IRIS RfD (2010) 0.03 mg/kg-day**
Endosulfan I and Endosulfan II (alpha and beta)	**115-29-7**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1994) 0.006 mg/kg-day ABS 0.1**

Endrin	**72-20-8**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1991) 0.0003 mg/kg-day ABS 0.1**
Ethylbenzene	**100-41-4**	**IRIS RfD[7]**	**IRIS RfD (1991) 0.1 mg/kg-day**
Extractable Petroleum Hydrocarbons (EPH) (Category 1)	**various**	**N.J.A.C. 7:26D – Appendix 2, Equation 5**	**See Table 1a – EPH Toxicity (below)**
Extractable Petroleum Hydrocarbons (EPH) (Category 2)	**various**	**N.J.A.C. 7:26D – Appendix 2, Equation 5**	**See Table 1a – EPH Toxicity (below)**
Fluoranthene	**206-44-0**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1993) 0.04 mg/kg-day ABS 0.13**
Fluorene	**86-73-7**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1990) 0.04 mg/kg-day ABS 0.13**
alpha-HCH (alpha-BHC)	**319-84-6**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) ATSDR RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1993) 6.3 (mg/kg-day)-1 ATSDR RfD (2013) 0.008 mg/kg-day ABS 0.1**
beta-HCH (beta-BHC)	**319-85-7**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) and Group C carcinogen factor**	**IRIS SF (1993) 1.8 (mg/kg-day)-1 ABS 0.1 Group C carcinogen factor 10**
Heptachlor	**76-44-8**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1993) 4.5 (mg/kg-day)-1 IRIS RfD (1991) 0.0005 mg/kg-day ABS 0.1**
Heptachlor epoxide	**1024-57-3**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1993) 9.1 (mg/kg-day)-1 IRIS RfD (1991) 0.000013 mg/kg-day ABS 0.1**
Hexachlorobenzene	**118-74-1**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1996) 1.6 (mg/kg-day)-1 IRIS RfD (1991) 0.0008 mg/kg-day ABS 0.1**
Hexachloro-1,3-butadiene	**87-68-3**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) PPRTV RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1991) 0.078 (mg/kg-day)-1 PPRTV RfD (2007) 0.001 mg/kg-day ABS 0.1**

		and a Group C carcinogen factor	**Group C carcinogen factor 10**
Hexachlorocyclopentadiene	**77-47-4**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (2001) 0.006 mg/kg-day ABS 0.1**
Hexachloroethane	**67-72-1**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (2011) 0.04 (mg/kg-day)-1 IRIS RfD (2003) 0.0007 mg/kg-day ABS 0.1**
n-Hexane	**110-54-3**	**HEAST RfD**	**HEAST RfD (1997) 0.06 mg/kg-day**
2-Hexanone	**591-78-6**	**IRIS RfD**	**IRIS RfD (2009) 0.005 mg/kg-day**
Indeno(1,2,3-cd) pyrene	**193-39-5**	**IRIS Slope Factor (SF) (benzo(a)pyrene – adjusted for indeno(1,2,3-cd)pyrene) with a dermal absorption fraction (ABS).**	**IRIS SF (2017) 1.0E-01(mg/kg-day)-1 (adjusted for indeno(1,2,3-cd)pyrene) ABS 0.13**
Isophorone	**78-59-1**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor**	**IRIS SF (1992) 0.00095 (mg/kg-day)-1 IRIS RfD (2003) 0.2 mg/kg-day ABS 0.1 Group C carcinogen factor 10**
Isopropylbenzene	**98-82-8**	**IRIS RfD**	**IRIS RfD (1997) 0.1 mg/kg-day**
Lead	**7439-92-1**	**USEPA IEUBK model for children USEPA ALM for adults**	**IEUBK (1994) Children ALM (1996) Adults**
Lindane (gamma-HCH) (gamma-BHC)	**58-89-9**	**CalEPA Slope Factor SF with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**CalEPA SF (1992) 1.1 (mg/kg-day)-1 IRIS RfD (1988) 0.0003 mg/kg-day ABS 0.1**
Manganese	**7439-96-5**	**EPA RSL RfD**	**EPA RSL RfD (2018) 0.024 mg/kg-day**
Mercury	**7439-97-6**	**IRIS RfD with a gastrointestinal absorption fraction (GIABS)**	**IRIS RfD (1995) 0.0003 mg/kg-day GIABS 0.07**
Methoxychlor	**72-43-5**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1991) 0.005 mg/kg-day ABS 0.1**
Methyl acetate	**79-20-9**	**HEAST RfD**	**HEAST RfD (1997) 1.0 mg/kg-day**

Methylene chloride	**75-09-2**	**NJDWQI Slope Factor (SF) IRIS RfD**	**NJDWQI SF (1994) 0.014 (mg/kg-day)-1 IRIS RfD (2011) 0.006 mg/kg-day**
2-Methylnaphthalene	**91-57-6**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (2003) 0.004 mg/kg-day ABS 0.13**
4-Methyl-2-pentanone	**108-10-1**	**HEAST RfD**	**HEAST RfD (1997) 0.08 mg/kg-day**
2-Methylphenol	**95-48-7**	**IRIS RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor**	**IRIS RfD (2008) 0.05 mg/kg-day ABS 0.1 Group C carcinogen factor 10**
4-Methylphenol	**106-44-5**	**ATSDR RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor**	**ATSDR RfD (2013) 0.1 mg/kg-day ABS 0.1 Group C carcinogen factor 10**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**NJDWQI RfD with a Group C carcinogen factor[8]**	**NJDWQI RfD (1994) 0.01 mg/kg-day (RfD includes Group C Carcinogen factor adjustment of 10)**
Naphthalene	**91-20-3**	**NJDWQI RfD with a dermal absorption fraction (ABS) and a Group C carcinogen factor**	**NJDWQI RfD (1994) 0.041 mg/kg-day ABS 0.13 (RfD includes Group C Carcinogen factor adjustment of 10)**
Nickel	**7440-02-0**	**IRIS RfD with a gastrointestinal absorption fraction (GIABS)**	**IRIS RfD (1996) 0.02 mg/kg-day GIABS 0.04**
4-Nitroaniline	**100-01-6**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) PPRTV RfD with a dermal absorption fraction (ABS)**	**PPRTV SF (2009) 0.02 (mg/kg-day)-1 PPRTV RfD (2009) 0.004 mg/kg-day ABS 0.1**
Nitrobenzene	**98-95-3**	**IRIS RfD**	**IRIS RfD (2009) 0.002 mg/kg-day**
N-Nitroso-di-n-propylamine	**621-64-7**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)**	**IRIS SF (1993) 7.0 (mg/kg-day)-1 ABS 0.1**
N-Nitrosodiphenylamine	**86-30-6**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)**	**IRIS SF (1993) 0.0049 (mg/kg-day)-1 ABS 0.1**
2,2'-Oxybis(1-choloropropane)	**108-60-1**	**IRIS RfD**	**IRIS RfD (1991) 0.04 mg/kg-day**

Pentachlorophenol	**87-86-5**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS SF (2010) 0.4 (mg/kg-day)-1 IRIS RfD (2010) 0.005 mg/kg-day ABS 0.25**
Phenol	**108-95-2**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (2002) 0.3 mg/kg-day ABS 0.1**
Polychlorinated biphenyls (PCBs)	**1336-36-3**	**NJDWQI Slope Factor (SF) with a dermal absorption fraction (ABS)**	**NJDWQI SF (1994) 2 (mg/kg-day)-1 ABS 0.14**
Pyrene	**129-00-0**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1993) 0.03 mg/kg-day ABS 0.13**
Selenium	**7782-49-2**	**IRIS RfD**	**IRIS RfD (1991) 0.005 mg/kg-day**
Silver	**7440-22-4**	**IRIS RfD with a gastrointestinal absorption fraction (GIABS)**	**IRIS RfD (1996) 0.005 mg/kg-day GIABS 0.04**
Styrene	**100-42-5**	**IRIS RfD**	**IRIS RfD (1990) 0.2 mg/kg-day**
Tertiary butyl alcohol (TBA)	**75-65-0**	**NJDEP RfD with a Group C carcinogen factor**	**NJDEP RfD (1997) 0.018 mg/kg-day (RfD includes Group C Carcinogen factor adjustment of 10)**
1,2,4,5-Tetrachlorobenzene	**95-94-3**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1991) 0.0003 mg/kg-day ABS 0.1**
2,3,7,8-Tetrachlorodibenzo-p-dioxin	**1746-01-6**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (2012) 7E-10 mg/kg-day ABS 0.03**
1,1,2,2-Tetrachloroethane	**79-34-5**	**IRIS Slope Factor (SF) IRIS RfD[9]**	**IRIS SF (2010) 0.2 (mg/kg-day)-1 IRIS RfD (2010) 0.02 mg/kg-day**
Tetrachloroethene (PCE)	**127-18-4**	**IRIS Slope Factor (SF) IRIS RfD[10]**	**IRIS SF (2012) 0.0021 (mg/kg-day)-1 IRIS RfD (2012) 0.006 mg/kg-day**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1992) 0.03 mg/kg-day ABS 0.1**
Toluene	**108-88-3**	**IRIS RfD**	**IRIS RfD (2005) 0.08 mg/kg-day**
Toxaphene	**8001-35-2**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS)**	**IRIS SF (1991) 1.1 (mg/kg-day)-1 ABS 0.1**

1,2,4-Trichlorobenzene	**120-82-1**	**IRIS RfD[11]**	**IRIS RfD (1996) 0.01 mg/kg-day ABS 0.1**
1,1,1-Trichloroethane	**71-55-6**	**IRIS RfD[12]**	**IRIS RfD (2007) 2 mg/kg-day**
1,1,2-Trichloroethane	**79-00-5**	**IRIS Slope Factor (SF) IRIS RfD with a Group C carcinogen factor[13]**	**IRIS SF (1994) 0.057 (mg/kg-day)-1 IRIS RfD (1994) 0.004 mg/kg-day Group C carcinogen factor 10**
Trichloroethene (TCE)	**79-01-6**	**IRIS Slope Factor (SF)[14] IRIS RfD**	**IRIS SF (2011) 0.046 (mg/kg-day)-1 IRIS RfD (2011) 0.0005 mg/kg-day**
Trichlorofluoromethane	**75-69-4**	**IRIS RfD**	**IRIS RfD (1992) 0.3 mg/kg-day**
2,4,5-Trichlorophenol	**95-95-4**	**IRIS RfD with a dermal absorption fraction (ABS)**	**IRIS RfD (1988) 0.1 mg/kg-day ABS 0.1**
2,4,6-Trichlorophenol	**88-06-2**	**IRIS Slope Factor (SF) with a dermal absorption fraction (ABS) PPRTV RfD with a dermal absorption fraction (ABS)**	**IRIS SF (1994) 0.011 (mg/kg-day)-1 PPRTV RfD (2007) 0.001 mg/kg-day ABS 0.1**
1,1,2-Trichloro-1,2,2-trifluoroethane	**76-13-1**	**No ingestion-based toxicity factors are available[15]**	**None**
1,2,4-Trimethylbenzene	**95-63-6**	**IRIS RfD**	**IRIS RfD (2016) 0.01 mg/kg-day**
Vanadium	**7440-62-2**	**EPA RSL RfD with a gastrointestinal absorption fraction (GIABS)**	**EPA RSL RfD (2018) 0.005 mg/kg-day GIABS 0.026**
Vinyl Chloride	**75-01-4**	**IRIS Slope Factor (SF) IRIS RfD[16]**	**IRIS SF (2000) 0.72 (mg/kg-day)-1 IRIS RfD (2000) 0.003 mg/kg-day**
Xylenes	**1330-20-7**	**NJDWQI RfD**	**NJDWQI RfD (1994) 0.15 mg/kg-day**
Zinc	**7440-66-6**	**IRIS RfD**	**IRIS RfD (2005) 0.3 mg/kg-day**

Table 1a – EPH Toxicity

Applies to both:

EPH - Category 1 (Number 2 Heating Oil/Diesel Fuel)

EPH - Category 2 (Heavier petroleum products)

Note: EPH excludes lighter petroleum products including gasoline and mineral spirits

Effective Carbon Range Aliphatics	Surrogate	Toxicity Factor	Toxicity Factor Reference Source
9 - 12	PHC Mixture	RfD 0.10 mg/kg-day ABS 0.1	Canada 2000 and MADEP 2003
12 - 16	PHC Mixture	RfD 0.10 mg/kg-day ABS 0.1	Canada 2000 and MADEP 2003
16 - 21	White Mineral Oil	RfD 2.0 mg/kg-day ABS 0.1	TPHCWG 1997 and MADEP 2003
21 - 40	White Mineral Oil	RfD 2.0 mg/kg-day ABS 0.1	TPHCWG 1997 and MADEP 2003
Effective Carbon Range Aromatics	**Surrogate**	**Toxicity Factor**	**Toxicity Factor Reference Source**
10 - 12	Naphthalene	RfD 0.041 mg/kg-day ABS 0.13	NJDWQI (1994)
12 - 16	Acenaphthene	RfD 0.06 mg/kg-day ABS 0.13	IRIS (1994)
16 - 21	Fluorene	RfD 0.04 mg/kg-day ABS 0.13	IRIS (1990)
21 - 36	Fluoranthene	RfD 0.04 mg/kg-day ABS 0.13	IRIS (1993)

[1] Both the NJDWQI slope factor and IRIS RfD for benzene are based on a route to route conversion of an inhalation study, which was determined to be acceptable by the USEPA as substantiated by additional evaluation including physiologically-based pharmacokinetic modeling.

[2] Although a NJDWQI RfD for 2-butanone exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based

on route to route conversion of toxicity factors. This policy conforms with the USEPA policy concerning route to route conversion of toxicity factors.

[3] Although a CalEPA slope factor for chloroform exists, the USEPA believes there is a threshold effect for cancer. As such, an RfD based soil remediation standard is protective of both cancer and non-cancer health endpoints.

[4] Although a CalEPA Slope Factor for 1,4-dichlorobenzene exists, there are questions about the study used to develop the slope factor. As such, the Department has decided not to develop an ingestion-dermal soil remediation standard for 1,4-dichlorobenzene using this slope factor.

[5] Although a NJDWQI RfD for 1,1-dichloroethane exists, it is based on an inhalation route to route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with the USEPA policy concerning route to route conversion of toxicity factors.

[6] Although a PPRTV RfD for 1,2-dichloroethane exists, it is listed as an appendix value. PPRTV appendix values are based on a study(s) that has flaws as determined by the USEPA. It is the Department's Site Remediation and Waste Management Program policy not to use PPRTV appendix values to develop soil remediation standards.

[7] Although a CalEPA slope factor for ethylbenzene exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards

based on route-to-route conversion of toxicity factors. This policy conforms with the USEPA policy concerning route-to-route conversion of toxicity factors.

[8] Although a CalEPA slope factor for methyl tert-butyl ether exists, there are questions about the study used to develop the slope factor. As such, the Department has decided not to develop an ingestion-dermal soil remediation standard for methyl tert-butyl ether using this slope factor.

[9] Although an NJDWQI RfD for 1,1,2,2-tetrachloroethane exists, the Department has decided to use an IRIS RfD to develop a non-cancer-based ingestion-dermal soil remediation standard as the IRIS RfD is based on a newer toxicology assessment.

[10] Although an NJDWQI slope factor for tetrachloroethene exists, the Department has decided that the existing IRIS Slope Factor is a scientifically better toxicity value to develop a cancer-based ingestion-dermal soil remediation standard. The IRIS slope factor uses the newest PBPK models (extrapolating from an inhalation unit risk factor to an oral slope factor). An ingestion-dermal soil remediation standard for tetrachloroethene can also be developed using an IRIS RfD. The RfD uses the newest PBPK models (extrapolating from an inhalation RfC to oral RfD).

[11] Although an NJDWQI RfD for 1,2,4-trichlorobenzene exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with the USEPA policy concerning route-to-route conversion of toxicity factors. In addition, a USEPA PPRTV slope factor for 1,2,4-trichlorobenzene is available, however the

Slope Factor is based on a controversial mouse liver tumor study that many researchers have dismissed. The Department has decided not to develop an ingestion-dermal soil remediation standard based on the PPRTV slope factor.

[12] Although an NJDWQI RfD for 1,1,1-trichloroethane exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

[13] Although an NJDWQI slope factor for 1,1,2-trichloroethane exists, the Department determined that the IRIS slope factor is a scientifically better toxicity value to develop a cancer-based ingestion-dermal soil remediation standard.

[14] Although an NJDWQI slope factor for trichloroethene exists, the Department determined that the IRIS slope factor is a scientifically better toxicity value to develop a cancer-based ingestion-dermal soil remediation standard. The IRIS slope factor uses the newest PBPK models (extrapolating from an inhalation unit risk factor to an oral slope factor).

[15] Although an IRIS RfD for 1,1,2-Trichloro-1,2,2-trifluoroethane exists, it is based on an inhalation route-to-route conversion. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

[16] Although an NJDWQI slope factor exists for vinyl chloride, the Department determined that the IRIS slope factor is a scientifically better toxicity value to develop a cancer-based ingestion – dermal soil remediation standard.

Table 2 – Soil Inhalation Toxicity Factors

Contaminant	CAS No.	Soil Inhalation Recommendation	Soil Inhalation Toxicity Factor(s)
Acenaphthene	83-32-9	No inhalation-based toxicity factors are available	None
Acetone	67-64-1	No inhalation-based toxicity factors are available[1]	None
Acetophenone	98-86-2	No inhalation-based toxicity factors are available[2]	None
Aldrin	309-00-2	No inhalation-based toxicity factors are available	None
Aluminum	7429-90-5	PPRTV RfC	PPRTV RfC (2006) 5E-03 mg/m3
Anthracene	120-12-7	No inhalation-based toxicity factors are available.	None
Antimony	7440-36-0	No inhalation-based toxicity factors are available.	None
Arsenic	7440-38-2	IRIS IUR	IRIS IUR (1998) 4.3E-03 (ug/m3)-1
Atrazine	1912-24-9	No inhalation-based toxicity factors are available	None
Barium	7440-39-3	HEAST RfC	HEAST RfC (1997) 5E-04 mg/m3
Benzaldehyde	100-52-7	No inhalation-based toxicity factors are available	None
Benzene	71-43-2	IRIS IUR IRIS RfC	IRIS IUR (2000) 7.8E-06 (ug/m3)-1 IRIS RfC (2003) 3E-02 mg/m3
Benzo(a)anthracene	56-55-3	IRIS IUR (benzo(a)pyrene) adjusted for benzo(a)anthracene	IRIS IUR (2017) 6.0E-05 (ug/m3)-1 (adjusted for benzo(a)anthracene)
Benzo(a)pyrene	50-32-8	IRIS IUR IRIS RfC	IRIS IUR (2017) 6.0E-04 (ug/m3)-1 IRIS RfC (2017) 2.0E-06 mg/m3

Benzo(b)fluoranthene	**205-99-2**	**IRIS IUR (benzo(a)pyrene) adjusted for benzo(b)fluoranthene**	**IRIS IUR (2017) 6.0E-05 (ug/m3)-1 (adjusted for benzo(b)fluoranthene)**
Benzo(k)fluoranthene	**207-08-9**	**IRIS IUR (benzo(a)pyrene) adjusted for benzo(k) fluoranthene**	**IRIS IUR (2017) 6.0E-06 (ug/m3)-1 (adjusted for benzo(k) fluoranthene)**
Beryllium	**7440-41-7**	**IRIS IUR IRIS RfC**	**IRIS IUR (1998) 2.4E-03 (ug/m3)-1 IRIS RfC (1998) 2E-05 mg/m3**
1,1'-Biphenyl	**92-52-4**	**No inhalation-based toxicity factors are available**	**None**
Bis(2-chloroethoxy) methane	**111-91-1**	**No inhalation-based toxicity factors are available**	**None**
Bis(2-chloroethyl) ether	**111-44-4**	**No inhalation-based toxicity factors are available**	**None**
Bis(2-ethylhexyl) phthalate	**117-81-7**	**No inhalation-based toxicity factors are available**	**None**
Bromodichloromethane	**75-27-4**	**No inhalation-based toxicity factors are available**	**None**
Bromoform	**75-25-2**	**No inhalation-based toxicity factors are available**	**None**
Bromomethane	**74-83-9**	**IRIS RfC**	**IRIS RfC (1992) 5E-03 mg/m3**
2-Butanone	**78-93-3**	**IRIS RfC[3]**	**IRIS RfC (2003) 5E+00 mg/m3**
Butylbenzylphthalate	**85-68-7**	**No inhalation-based toxicity factors are available**	**None**
Cadmium	**7440-43-9**	**IRIS IUR ATSDR RfC**	**IRIS IUR (1992) 1.8E-03 (ug/m3)-1 ATSDR RfC (2013) 1E-05 mg/m3**
Caprolactam	**105-60-2**	**CalEPA RfC**	**CalEPA RfC (2013) 2.2E-03 mg/m3**
Carbon disulfide	**75-15-0**	**IRIS RfC**	**IRIS RfC (1995) 7E-01 mg/m3**
Carbon tetrachloride	**56-23-5**	**IRIS IUR IRIS RfC**	**IRIS IUR (2010) 6E-06 (ug/m3)-1 IRIS RfC (2010) 1E-01 mg/m3**
Chlordane (alpha plus gamma mixture)	**57-74-9**	**IRIS RfC**	**IRIS RfC (1998) 7E-04 mg/m3**
4-Chloroaniline	**106-47-8**	**No inhalation-based toxicity factors are available**	**None**
Chlorobenzene	**108-90-7**	**PPRTV RfC**	**PPRTV RfC (2006) 5E-02 mg/m3**

Chloroethane	**75-00-3**	**IRIS RfC**	**IRIS RfC (1991) 1E+01 mg/m3**
Chloroform	**67-66-3**	**ATSDR RfC**	**ATSDR RfC (2013) 9.8E-02 mg/m3**
Chloromethane	**74-87-3**	**IRIS RfC[4]**	**IRIS RfC (2001) 9E-02 mg/m3**
2-Chloronaphthalene	**91-58-7**	**No inhalation-based toxicity factors are available**	**None**
2-Chlorophenol	**95-57-8**	**No inhalation-based toxicity factors are available**	**None**
Chrysene	**218-01-9**	**IRIS IUR (benzo(a)pyrene) adjusted for chrysene**	**IRIS IUR (2017) 6.0E-07 (ug/m3)-1 (adjusted for chrysene)**
Cobalt	**7440-48-4**	**PPRTV IUR PPRTV RfC.**	**PPRTV IUR (2008) 9E-03(ug/m3)-1 PPRTV RfC (2008) 6E-06 mg/m3**
Copper	**7440-50-8**	**No inhalation-based toxicity factors are available[5]**	**None**
Cyanide	**57-12-5**	**IRIS RfC**	**IRIS RfC (2010) 8E-04 mg/m3**
Cyclohexane	**110-82-7**	**IRIS RfC**	**IRIS RfC (2003) 6E+00 mg/m3**
4,4'-DDD	**72-54-8**	**No inhalation-based toxicity factors are available**	**None**
4,4'-DDE	**72-55-9**	**No inhalation-based toxicity factors are available**	**None**
4,4'-DDT	**50-29-3**	**No inhalation-based toxicity factors are available**	**None**
Dibenz(a,h)anthracene	**53-70-3**	**IRIS IUR (benzo(a)pyrene) adjusted for dibenzo(a,h) anthracene**	**IRIS IUR (2017) 6.0E-04(ug/m3)-1 (adjusted for dibenzo(a,h) anthracene)**
Dibromochloromethane	**124-48-1**	**No inhalation-based toxicity factors are available**	**None**
1,2-Dibromo-3-chloropropane	**96-12-8**	**PPRTV IUR IRIS RfC**	**PPRTV IUR (2006) 6E-03 (ug/m3)-1 IRIS RfC (1991) 2E-04 mg/m3**
1,2-Dibromoethane	**106-93-4**	**IRIS IUR IRIS RfC**	**IRIS IUR (2004) 6E-04 (ug/m3)-1 IRIS RfC (2004) 9E-03 mg/m3**
1,2-Dichlorobenzene	**95-50-1**	**HEAST RfC**	**HEAST RfC (1997) 2E-01 mg/m3**
1,3-Dichlorobenzene	**541-73-1**	**No inhalation-based toxicity factors are available**	**None**
1,4-Dichlorobenzene	**106-46-7**	**IRIS RfC**	**IRIS RfC (1994) 8E-01 mg/m3**

3,3'-Dichlorobenzidine	**91-94-1**	**No inhalation-based toxicity factors are available**	**None**
Dichlorodifluoromethane	**75-71-8**	**No inhalation-based toxicity factors are available[6]**	**None**
1,1-Dichloroethane	**75-34-3**	**No inhalation-based toxicity factors are available[7]**	**None**
1,2-Dichloroethane	**107-06-2**	**PPRTV RfC**	**PPRTV RfC (2010) 7E-03 mg/m3**
1,1-Dichloroethene	**75-35-4**	**A soil inhalation remediation standard can be developed using an IRIS RfC with a Group C carcinogen factor**	**IRIS RfC (2002/2005) 2E-01 mg/m3 RfC Group C carcinogen factor 10**
cis-1,2-Dichloroethene	**156-59-2**	**No inhalation-based toxicity factors are available**	**None**
trans-1,2-Dichloroethene	**156-60-5**	**No inhalation-based toxicity factors are available[8]**	**None**
2,4-Dichlorophenol	**120-83-2**	**No inhalation-based toxicity factors are available**	**None**
1,2-Dichloropropane	**78-87-5**	**PPRTV IUR IRIS RfC**	**PPRTV IUR (2016) 3.7E-06 (ug/m3)-1 IRIS RfC (1991) 4E-03 mg/m3**
1,3-Dichloropropene (cis and trans)	**542-75-6**	**IRIS IUR IRIS RfC**	**IRIS IUR (2000) 4E-06 (ug/m3)-1 IRIS RfC (2000) 2E-02 mg/m3**
Dieldrin	**60-57-1**	**No inhalation-based toxicity factors are available**	**None**
Diethylphthalate	**84-66-2**	**No inhalation-based toxicity factors are available**	**None**
2,4-Dimethylphenol	**105-67-9**	**No inhalation-based toxicity factors are available**	**None**
Di-n-butylphthalate	**84-74-2**	**No inhalation-based toxicity factors are available**	**None**
2,4-Dinitrophenol	**51-28-5**	**No inhalation-based toxicity factors are available**	**None**
2,4-Dinitrotoluene /2,6-Dinitrotoluene (mixture)	**25321-14-6**	**No inhalation-based toxicity factors are available**	**None**
Di-n-octylphthalate	**117-84-0**	**No inhalation-based toxicity factors are available[9]**	**None**
1,4-Dioxane	**123-91-1**	**IRIS IUR IRIS RfC**	**IRIS IUR (2013) 5.0E-06 (ug/m3)-1 IRIS RfC (2013) 3E-02 mg/m3**
Endosulfan I and Endosulfan II (alpha and beta)	**115-29-7**	**No inhalation-based toxicity factors are available**	**None**
Endrin	**72-20-8**	**No inhalation-based toxicity factors are available**	**None**
Ethylbenzene	**100-41-4**	**CalEPA IUR**	**CalEPA IUR (2007)**

		IRIS RfC	**2.5E-06 (ug/m3)-1 IRIS RfC (1991) 1E+00 mg/m3**
Extractable Petroleum Hydrocarbons (EPH) (Category 1)	**various**	**No inhalation-based toxicity factors are available**	**None**
Extractable Petroleum Hydrocarbons (EPH) (category 2)	**various**	**No inhalation-based toxicity factors are available**	**None**
Fluoranthene	**206-44-0**	**No inhalation-based toxicity factors are available**	**None**
Fluorene	**86-73-7**	**No inhalation-based toxicity factors are available**	**None**
alpha-HCH (alpha-BHC)	**319-84-6**	**No inhalation-based toxicity factors are available**	**None**
beta-HCH (beta-BHC)	**319-85-7**	**No inhalation-based toxicity factors are available**	**None**
Heptachlor	**76-44-8**	**No inhalation-based toxicity factors are available**	**None**
Heptachlor epoxide	**1024-57-3**	**No inhalation-based toxicity factors are available**	**None**
Hexachlorobenzene	**118-74-1**	**No inhalation-based toxicity factors are available.**	**None**
Hexachloro-1,3-butadiene	**87-68-3**	**No inhalation-based toxicity factors are available**	**None**
Hexachlorocyclopentadiene	**77-47-4**	**IRIS RfC**	**IRIS RfC (2001) 2E-04 mg/m3**
Hexachloroethane	**67-72-1**	**IRIS RfC**	**IRIS RfC (2011) 3E-02 mg/m3**
n-Hexane	**110-54-3**	**IRIS RfC**	**IRIS RfC (2005) 7E-01 mg/m3**
2-Hexanone	**591-78-6**	**IRIS RfC**	**IRIS RfC (2009) 3E-02 mg/m3**
Indeno(1,2,3,-cd) pyrene	**193-39-5**	**IRIS IUR (benzo(a)pyrene) adjusted for indeno(1,2,3,-cd) pyrene.**	**IRIS IUR (2017) 6.0E-05 (ug/m3)-1 (adjusted for indeno(1,2,3,-cd) pyrene)**
Isophorone	**78-59-1**	**CalEPA RfC**	**CalEPA RfC (2001) 2E-00 mg/m3**
Isopropylbenzene	**98-82-8**	**IRIS RfC**	**IRIS RfC (1997) 4E-01 mg/m3**
Lead	**7439-92-1**	**No inhalation-based toxicity factors are available**	**None**
Lindane (gamma-HCH) (gamma-BHC)	**58-89-9**	**No inhalation-based toxicity factors are available**	**None**
Manganese	**7439-96-5**	**IRIS RfC.**	**IRIS RfC (1993) 5E-05 mg/m3**
Mercury	**7439-97-6**	**IRIS RfC**	**IRIS RfC (1995) 3E-04 mg/m3**

Methoxychlor	**72-43-5**	**No inhalation-based toxicity factors are available**	**None**
Methyl acetate	**79-20-9**	**No inhalation-based toxicity factors are available**	**None**
Methylene chloride	**75-09-2**	**IRIS IUR IRIS RfC**	**IRIS IUR (2011) 1E-8 (ug/m3)-1 IRIS RfC (2011) 6E-01 mg/m3**
2-Methylnaphthalene	**91-57-6**	**No inhalation-based toxicity factors are available**	**None**
4-Methyl-2-pentanone	**108-10-1**	**IRIS RfC**	**IRIS RfC (2003) 3E+0 mg/m3**
2-Methylphenol	**95-48-7**	**No inhalation-based toxicity factors are available**	**None**
4-Methylphenol	**106-44-5**	**No inhalation-based toxicity factors are available**	**None**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**IRIS RfC with a Group C carcinogen factor CalEPA IUR.**	**CalEPA IUR (1999) 2.6E-07 (ug/m3)-1 IRIS RfC (1993) 3E+0 mg/m3 Group C carcinogen factor 10**
Naphthalene	**91-20-3**	**CalEPA IUR IRIS RfC with a Group C carcinogen factor**	**CalEPA IUR (2011) 3.4E-05 (ug/m3)-1 IRIS RfC (1998) 3E-03 mg/m3 Group C carcinogen factor 10**
Nickel	**7440-02-0**	**IRIS IUR CalEPA RfC.**	**IRIS IUR (1987/2006) 2.4E-04 (ug/m3)-1 CalEPA RfC (2012) 1.4E-05 mg/m3**
4-Nitroaniline	**100-01-6**	**PPRTV RfC**	**PPRTV RfC (2009) 6E-03 mg/m3**
Nitrobenzene	**98-95-3**	**IRIS IUR IRIS RfC.**	**IRIS IUR (2009) 4E-05 (ug/m3)-1 IRIS RfC (2009) 9E-03 mg/m3**
N-Nitroso-di-n- propylamine	**621-64-7**	**No inhalation-based toxicity factors are available**	**None**
N-Nitrosodiphenylamine	**86-30-6**	**No inhalation-based toxicity factors are available**	**None**
2,2'-Oxybis(1-choloropropane)	**108-60-1**	**No inhalation-based toxicity factors are available**	**None**
Pentachlorophenol	**87-86-5**	**No inhalation-based toxicity factors are available**	**None**
Phenol	**108-95-2**	**CalEPA RfC**	**CalEPA RfC (2000) 2E-01 mg/m3**

Polychlorinated biphenyls (PCBs)	**1336-36-3**	**No inhalation-based toxicity factors are available**	**None**
Pyrene	**129-00-0**	**No inhalation-based toxicity factors are available**	**None**
Selenium	**7782-49-2**	**No inhalation-based toxicity factors are available**	**None**
Silver	**7440-22-4**	**No inhalation-based toxicity factors are available**	**None**
Styrene	**100-42-5**	**IRIS RfC[10]**	**IRIS RfC (1992) 1E+0 mg/m3**
Tertiary butyl alcohol (TBA)	**75-65-0**	**No inhalation-based toxicity factors are available**	**None**
1,2,4,5-Tetrachlorobenzene	**95-94-3**	**No inhalation-based toxicity factors are available**	**None**
2,3,7,8-Tetrachlorodibenzo-p-dioxin	**1746-01-6**	**No inhalation-based toxicity factors are available**	**None**
1,1,2,2-Tetrachloroethane	**79-34-5**	**No inhalation-based toxicity factors are available**	**None**
Tetrachloroethene (PCE)	**127-18-4**	**IRIS IUR IRIS RfC**	**IRIS IUR (2012) 2.6E-07 (ug/m3)-1 IRIS RfC (2012) 4E-02 mg/m3**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**No inhalation-based toxicity factors are available**	**None**
Toluene	**108-88-3**	**IRIS RfC**	**IRIS RfC (2005) 5E+0 mg/m3**
Toxaphene	**8001-35-2**	**No inhalation-based toxicity factors are available**	**None**
1,2,4-Trichlorobenzene	**120-82-1**	**PPRTV RfC**	**PPRTV RfC (2009) 2E-03 mg/m3**
1,1,1-Trichloroethane	**71-55-6**	**IRIS RfC[11]**	**IRIS RfC (2007) 5E+0 mg/m3**
1,1,2-Trichloroethane	**79-00-5**	**No inhalation-based toxicity factors are available[12]**	**None**
Trichloroethene (TCE)	**79-01-6**	**IRIS IUR IRIS RfC[13]**	**IRIS IUR (2011) 4.1E-6 (ug/m3)-1 IRIS RfC (2011) 2E-3 mg/m3**
Trichlorofluoromethane	**75-69-4**	**No inhalation-based toxicity factors are available[14]**	**None**
2,4,5-Trichlorophenol	**95-95-4**	**No inhalation-based toxicity factors are available**	**None**
2,4,6-Trichlorophenol	**88-06-2**	**No inhalation-based toxicity factors are available**	**None**
1,1,2-Trichloro-1,2,2-trifluoroethane	**76-13-1**	**PPRTV RfC**	**PPRTV RfC (2016) 5E+00 mg/m3**
1,2,4-Trimethylbenzene	**95-63-6**	**IRIS RfC**	**IRIS RfC (2016) 6E-02 mg/m3**

Vanadium	**7440-62-2**	**ATSDR RfC**	**ATSDR RfC (2012) 1E-04 mg/m3**
Vinyl Chloride	**75-01-4**	**IRIS IUR IRIS RfC[15]**	**IRIS IUR (2000) 4.4E-6 (ug/m3)-1 IRIS RfC (2000) 1E-1 mg/m3**
Xylenes	**1330-20-7**	**IRIS RfC**	**IRIS RfC (2003) 1.E-01 mg/m3**
Zinc	**7440-66-6**	**No inhalation-based toxicity factors are available[16]**	**None**

[1] An ATSDR RfC exists for acetone using the results of the Stewart 1975 study. The USEPA IRIS notes that this study should only be used in the development of a short-term exposure RfC and not a long-term (chronic) exposure RfC.

[2] A HEAST RfC exists for acetophenone, but a subsequent PPRTV review (2010) questions the use of the HEAST RfC.

[3] A NJDWQI RfC exists for 2-butanone, but the IRIS RfC has been determined by the Department to be more appropriate. The existing NJDWQI RfC is based on a route-to-route conversion of a NJDWQI RfD. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route-to-route conversion of toxicity factors.

[4] A HEAST IUR exists for chloromethane, but a subsequent PPRTV review (2012) states that the use of the HEAST IUR is "Inadequate for an assessment of carcinogenic potential."

[5] A CalEPA RfC that once existed for copper has been retracted by CalEPA.

[6] A HEAST RfC and a PPRTV RfC exist for dichlorodifluoromethane. Both RfCs are derived using the same study (Prendergast 1967). The PPRTV is listed as an appendix value. The PPRTV RfC is

listed as an appendix value because the Prendergast study was determined by the USEPA to have flaws. It is the Department's Site Remediation and Waste Management Program policy not to use PPRTV appendix values to develop soil remediation standards. As the HEAST RfC developed using the Prendergast study, the Department decided not to use this RfC in the development of a soil remediation standard.

[7] A HEAST RfC exists for 1,1-dichloroethane, but a subsequent PPRTV review (2006) indicated that data were inadequate to derive a chronic exposure RfC for 1,1-dichloroethane.

[8] A PPRTV RfC exists for trans-1,2-dichloroethene but a subsequent IRIS assessment (2010) stated "the available inhalation data from the Freund study are insufficient to support reference value derivation and RfC."

[9] A 1985 USEPA IUR that once existed for di-n-octylphthalate has been retracted by the USEPA.

[10] A HEAST 1991 IUR exists for styrene but USEPA NCEA does not recommend its use.

[11] Although an NJDWQI RfC exists for 1,1,1-trichloroethane, the Department determined that the IRIS RfC is a scientifically better toxicity value to develop a non-cancer-based soil inhalation remediation standard.

[12] Although a PPRTV RfC for 1,1,2-trichloroethane exists, it is listed as an appendix value. The PPRTV appendix value is based on a study that was determined by USEPA to have flaws. It is the Department's Site Remediation and Waste Management Program policy not to use PPRTV appendix values to develop soil remediation standards.

[13] The IRIS RfC for trichloroethene is based on a route-to-route conversion of an ingestion study, which was determined to be acceptable by the USEPA as substantiated by additional evaluation including physiologically-based pharmacokinetic modeling.

[14] A HEAST RfC exists for trichlorofluoromethane, but a subsequent PPRTV review (2009) indicated that data used to derive the RfC were inadequate.

[15] The IRIS RfC for vinyl chloride is based on a route-to-route conversion of an ingestion study, which was determined to be acceptable by the USEPA as substantiated by additional evaluation including physiologically-based pharmacokinetic modeling.

[16] A CalEPA RfC that once existed for zinc has been retracted by CalEPA.

Table 3 – Indoor Air Toxicity Factors

Contaminant	CAS No.	VI Recommendation	VI Toxicity Factor(s)
Acenaphthene	83-32-9	Not applicable	Not applicable
Acetone	67-64-1	No inhalation-based toxicity factors are available[1]	None
Acetophenone	98-86-2	Not applicable	Not applicable
Aldrin	309-00-2	Not applicable	Not applicable
Aluminum	7429-90-5	Not applicable	Not applicable
Anthracene	120-12-7	Not applicable	Not applicable

Antimony	**7440-36-0**	**Not applicable**	**Not applicable**
Arsenic	**7440-38-2**	**Not applicable**	**Not applicable**
Atrazine	**1912-24-9**	**Not applicable**	**Not applicable**
Barium	**7440-39-3**	**Not applicable**	**Not applicable**
Benzaldehyde	**100-52-7**	**Not applicable**	**Not applicable**
Benzene	**71-43-2**	**IRIS IUR IRIS RfC.**	**IRIS IUR (2000) 7.8E-06 (ug/m3)-1 IRIS RfC (2003) 3E-02 mg/m3**
Benzo(a)anthracene	**56-55-3**	**Not applicable**	**Not applicable**
Benzo(a)pyrene	**50-32-8**	**Not applicable**	**Not applicable**
Benzo(b)fluoranthene	**205-99-2**	**Not applicable**	**Not applicable**
Benzo(k)fluoranthene	**207-08-9**	**Not applicable**	**Not applicable**
Beryllium	**7440-41-7**	**Not applicable**	**Not applicable**
1,1'-Biphenyl	**92-52-4**	**Not applicable**	**Not applicable**
Bis(2-chloroethoxy) methane	**111-91-1**	**Not applicable**	**Not applicable**

Bis(2-chloroethyl) ether	**111-44-4**	**Not applicable**	**Not applicable**
Bis(2-ethylhexyl) phthalate	**117-81-7**	**Not applicable**	**Not applicable**
Bromodichloromethane	**75-27-4**	**No inhalation-based toxicity factors are available**	**None**
Bromoform	**75-25-2**	**No inhalation-based toxicity factors are available**	**None**
Bromomethane	**74-83-9**	**IRIS RfC**	**IRIS RfC (1992) 5E-03 mg/m3**
2-Butanone	**78-93-3**	**VI standard can be developed using IRIS RfC[2]**	**IRIS RfC (2003) 5E+00 mg/m3**
Butylbenzylphthalate	**85-68-7**	**Not applicable**	**Not applicable**
Cadmium	**7440-43-9**	**Not applicable**	**Not applicable**
Caprolactam	**105-60-2**	**Not applicable**	**Not applicable**
Carbon disulfide	**75-15-0**	**IRIS RfC**	**IRIS RfC (1995) 7E-01 mg/m3**
Carbon tetrachloride	**56-23-5**	**IRIS IUR IRIS RfC**	**IRIS IUR (2010) 6E-06 (ug/m3)-1 IRIS RfC (2010) 1E-01 mg/m3**
Chlordane (alpha plus gamma mixture)	**57-74-9**	**Not applicable**	**Not applicable**
4-Chloroaniline	**106-47-8**	**Not applicable**	**Not applicable**

Chlorobenzene	**108-90-7**	**PPRTV RfC**	**PPRTV RfC (2006) 5E-02 mg/m3**
Chloroethane	**75-00-3**	**IRIS RfC**	**IRIS RfC (1991) 1E+01 mg/m3**
Chloroform	**67-66-3**	**ATSDR RfC**	**ATSDR RfC (2013) 9.8E-02 mg/m3**
Chloromethane	**74-87-3**	**IRIS RfC[3]**	**IRIS RfC (2001) 9E-02 mg/m3**
2-Chloronaphthalene	**91-58-7**	**Not applicable**	**Not applicable**
2-Chlorophenol	**95-57-8**	**Not applicable**	**Not applicable**
Chrysene	**218-01-9**	**Not applicable**	**Not applicable**
Cobalt	**7440-48-4**	**Not applicable**	**Not applicable**
Copper	**7440-50-8**	**Not applicable**	**Not applicable**
Cyanide	**57-12-5**	**Not applicable**	**Not applicable**
Cyclohexane	**110-82-7**	**IRIS RfC**	**IRIS RfC (2003) 6E+00 mg/m3**
4,4'-DDD	**72-54-8**	**Not applicable**	**Not applicable**
4,4'-DDE	**72-55-9**	**Not applicable**	**Not applicable**
4,4'-DDT	**50-29-3**	**Not applicable**	**Not applicable**
Dibenz(a,h)anthracene	**53-70-3**	**Not applicable**	**Not applicable**

Dibromochloromethane	**124-48-1**	**No inhalation-based toxicity factors are available.**	**None**
1,2-Dibromo-3-chloropropane	**96-12-8**	**Not applicable**	**None**
1,2-Dibromoethane	**106-93-4**	**IRIS IUR IRIS RfC**	**IRIS IUR (2004) 6E-04 (ug/m3)-1 IRIS RfC (2004) 9E-03 mg/m3**
1,2-Dichlorobenzene	**95-50-1**	**HEAST RfC**	**HEAST RfC (1997) 2E-01 mg/m3**
1,3-Dichlorobenzene	**541-73-1**	**No inhalation-based toxicity factors are available**	**None**
1,4-Dichlorobenzene	**106-46-7**	**IRIS RfC**	**IRIS RfC (1996) 8E-01 mg/m3**
3,3'-Dichlorobenzidine	**91-94-1**	**Not applicable**	**Not applicable**
Dichlorodifluoromethane	**75-71-8**	**No inhalation-based toxicity factors are available[4]**	**None**
1,1-Dichloroethane	**75-34-3**	**No inhalation-based toxicity factors are available[5]**	**None**
1,2-Dichloroethane	**107-06-2**	**PPRTV RfC**	**PPRTV RfC (2010) 7E-03 mg/m3**

1,1-Dichloroethene	**75-35-4**	**IRIS RfC with a Group C carcinogen factor**	**IRIS RfC (2002/2005) 2E-01 mg/m3 Group C carcinogen factor 10**
cis-1,2-Dichloroethene	**156-59-2**	**No inhalation-based toxicity factors are available**	**None**
trans-1,2-Dichloroethene	**156-60-5**	**No inhalation-based toxicity factors are available[6]**	**None**
2,4-Dichlorophenol	**120-83-2**	**Not applicable**	**Not applicable**
1,2-Dichloropropane	**728-87-5**	**PPRTV IUR IRIS RfC**	**PPRTV IUR (2016) 3.7E-06 (ug/m3)-1 IRIS RfC (1991) 4E-03 mg/m3**
1,3-Dichloropropene (cis and trans)	**5422-75-6**	**IRIS IUR IRIS RfC**	**IRIS IUR (2000) 4E-06 (ug/m3)-1 IRIS RfC (2000) 2E-02 mg/m3**
Dieldrin	**60-57-1**	**Not applicable**	**Not applicable**
Diethylphthalate	**84-66-2**	**Not applicable**	**Not applicable**
2,4-Dimethylphenol	**105-67-9**	**Not applicable**	**Not applicable**
Di-n-butylphthalate	**84-74-2**	**Not applicable**	**Not applicable**
2,4-Dinitrophenol	**51-28-5**	**Not applicable**	**Not applicable**
2,4-Dinitrotoluene /2,6-Dinitrotoluene (mixture)	**25321-14-6**	**Not applicable**	**Not applicable**
Di-n-octyl phthalate	**117-84-0**	**Not applicable**	**Not applicable**

1,4-Dioxane	**123-91-1**	**IRIS IUR IRIS RfC**	**IRIS IUR (2013) 5.0E-06 (ug/m3)-1 IRIS RfC (2013) 3E-02 mg/m3**
Endosulfan I and Endosulfan II (alpha and beta)	**115-29-7**	**Not applicable**	**Not applicable**
Endrin	**72-20-8**	**Not applicable**	**Not applicable**
Ethylbenzene	**100-41-4**	**CalEPA IUR IRIS RfC**	**CalEPA IUR (2007) 2.5E-06 (ug/m3)-1 IRIS RfC (1991) 1E+00 mg/m3**
Extractable Petroleum Hydrocarbons (EPH) (Category 1)	**various**	**Not applicable**	**Not applicable**
Extractable Petroleum Hydrocarbons (EPH) (Category 2)	**various**	**Not applicable**	**Not applicable**
Fluoranthene	**206-44-0**	**Not applicable**	**Not applicable**
Fluorene	**86-73-7**	**Not applicable**	**Not applicable**
alpha-HCH (alpha-BHC)	**319-84-6**	**Not applicable**	**Not applicable**
beta-HCH (beta-BHC)	**319-85-7**	**Not applicable**	**Not applicable**
Heptachlor	**76-44-8**	**Not applicable**	**Not applicable**
Heptachlor epoxide	**1024-57-3**	**Not applicable**	**Not applicable**

Hexachlorobenzene	**118-74-1**	**Not applicable**	**Not applicable**
Hexachloro-1,3-butadiene	**87-68-3**	**Not applicable**	**Not applicable**
Hexachlorocyclopentadiene	**77-47-4**	**Not applicable**	**Not applicable**
Hexachloroethane	**67-72-1**	**Not applicable**	**Not applicable**
n-Hexane	**110-54-3**	**IRIS RfC**	**IRIS RfC (2005) 7E-01 mg/m3**
2-Hexanone	**591-78-6**	**Not applicable**	**Not applicable**
Indeno(1,2,3,-cd) pyrene	**193-39-5**	**Not applicable**	**Not applicable**
Isophorone	**78-59-1**	**Not applicable**	**Not applicable**
Isopropylbenzene	**98-82-8**	**Not applicable**	**Not applicable**
Lead	**7439-92-1**	**Not applicable**	**Not applicable**
Lindane (gamma-HCH) (gamma-BHC)	**58-89-9**	**Not applicable**	**Not applicable**
Manganese	**7439-96-5**	**Not applicable**	**Not applicable**
Mercury	**7439-97-6**	**IRIS RfC**	**IRIS RfC (1995) 3E-04 mg/m3**
Methoxychlor	**72-43-5**	**Not applicable**	**Not applicable**

Methyl acetate	**79-20-9**	**No inhalation-based toxicity factors are available**	**None**
Methylene chloride	**75-09-2**	**IRIS IUR RfC**	**IRIS IUR (2011) 1E-8 (ug/m3)-1 IRIS RfC (2011) 6E-01 mg/m3**
2-Methylnaphthalene	**91-57-6**	**Not applicable**	**Not applicable**
4-Methyl-2-pentanone	**108-10-1**	**IRIS RfC**	**IRIS RfC (2003) 3E+0 mg/m3**
2-Methylphenol	**95-48-7**	**Not applicable**	**Not applicable**
4-Methylphenol	**106-44-5**	**Not applicable**	**Not applicable**
Methyl tert-butyl ether (MTBE)	**1634-04-4**	**IRIS RfC CalEPA IUR**	**CalEPA IUR (1999) 2.6E-07 (ug/m3)-1 IRIS RfC (1993) 3E+0 mg/m3**
Naphthalene	**91-20-3**	**CalEPA IUR IRIS RfC with a Group C carcinogen factor**	**CalEPA IUR (2004) 3.4E-05 (ug/m3)-1 IRIS RfC (1998) 3E-03 mg/m3 Group C carcinogen**
Nickel	**7440-02-0**	**Not applicable**	**Not applicable**
4-Nitroaniline	**100-01-6**	**Not applicable**	**Not applicable**
Nitrobenzene	**98-95-3**	**Not applicable**	**Not applicable**

N-Nitroso-di-n propylamine	**621-64-7**	**Not applicable**	**Not applicable**
N-Nitrosodiphenylamine	**86-30-6**	**Not applicable**	**Not applicable**
2,2'-Oxybis(1-choloropropane)	**108-60-1**	**Not applicable**	**Not applicable**
Pentachlorophenol	**87-86-5**	**Not applicable**	**Not applicable**
Phenol	**108-95-2**	**Not applicable**	**Not applicable**
Polychlorinated biphenyls (PCBs)	**1336-36-3**	**Not applicable**	**Not applicable**
Pyrene	**129-00-0**	**Not applicable**	**Not applicable**
Selenium	**7782-49-2**	**Not applicable**	**Not applicable**
Silver	**7440-22-4**	**Not applicable**	**Not applicable**
Styrene	**100-42-5**	**VI standard can be developed using IRIS RfC[7]**	**IRIS RfC (1993) 1E+0 mg/m3**
Tertiary butyl alcohol (TBA)	**75-65-0**	**No inhalation-based toxicity factors are available**	**None**
1,2,4,5-Tetrachlorobenzene	**95-94-3**	**Not applicable**	**Not applicable**
2,3,7,8-Tetrachlorodibenzo-p-dioxin	**1746-01-6**	**Not applicable**	**Not applicable**
1,1,2,2-Tetrachloroethane	**79-34-5**	**No inhalation-based toxicity factors are available**	**None**

Tetrachloroethene (PCE)	**127-18-4**	**IRIS IUR IRIS RfC**	**IRIS IUR (2012) 2.6E-07 (ug/m3)-1 IRIS RfC (2012) 4E-02 mg/m3**
2,3,4,6-Tetrachlorophenol	**58-90-2**	**Not applicable**	**Not applicable**
Toluene	**108-88-3**	**IRIS RfC**	**IRIS RfC (2005) 5E+0 mg/m3**
Toxaphene	**8001-35-2**	**Not applicable**	**Not applicable**
1,2,4-Trichlorobenzene	**120-82-1**	**PPRTV RfC**	**PPRTV RfC (2009) 2E-03 mg/m3**
1,1,1-Trichloroethane	**71-55-6**	**IRIS RfC[8]**	**IRIS RfC (2007) 5E+0 mg/m3**
1,1,2-Trichloroethane	**79-00-5**	**No inhalation-based toxicity factors are available[9]**	**None**
Trichloroethene (TCE)	**79-01-6**	**IRIS IUR IRIS RfC[10]**	**IRIS IUR (2011) 4.1E-6 (ug/m3)-1 IRIS RfC (2011) 2E-3 mg/m3**
Trichlorofluoromethane	**75-69-4**	**No inhalation-based toxicity factors are available[11]**	**None**
2,4,5-Trichlorophenol	**95-95-4**	**Not applicable**	**Not applicable**
2,4,6-Trichlorophenol	**88-06-2**	**Not applicable**	**Not applicable**
1,1,2-Trichloro-1,2,2-trifluoroethane	**76-13-1**	**PPRTV RfC**	**PPRTV RfC (2016) 5E+00 mg/m3**

1,2,4-Trimethylbenzene	**95-63-6**	**IRIS RfC**	**IRIS RfC (2016) 6E-02 mg/m3**
Vanadium	**7440-62-2**	**Not applicable**	**Not applicable**
Vinyl Chloride	**75-01-4**	**IRIS IUR. IRIS RfC[12]**	**IRIS IUR (2000) 4.4E-6 (ug/m3)-1 IRIS RfC (2000) 1E-1 mg/m3**
Xylenes	**1330-20-7**	**IRIS RfC**	**IRIS RfC (2003) 1.E-01 mg/m3**
Zinc	**7440-66-6**	**Not applicable**	**Not applicable**

[1] An ATSDR RfC exists for acetone using the results of the Stewart 1975 study. The USEPA IRIS notes that this study should only be used in the development of a short-term exposure RfC and not a long-term (chronic) exposure RfC.

[2] A NJDWQI RfC exists for 2-butanone, but the IRIS RfC has been determined by the Department to be more appropriate. The existing NJDWQI RfC is based on a route-to-route conversion of a NJDWQI RfD. The Department's Site Remediation and Waste Management Program policy does not allow, except where warranted, for the development of soil remediation standards based on route-to-route conversion of toxicity factors. This policy conforms with the USEPA policy concerning route-to-route conversion of toxicity factors.

[3] A HEAST IUR exists for chloromethane, but a subsequent PPRTV review (2012) states that the use of the HEAST IUR is "Inadequate for an assessment of carcinogenic potential."

[4] A HEAST RfC and a PPRTV RfC exist for dichlorodifluoromethane. Both RfCs are derived using the same study (Prendergast 1967). The PPRTV is listed as an appendix value. The PPRTV RfC is listed as an appendix value because the Prendergast study was determined by the USEPA to have flaws. It is the Department's Site Remediation and Waste Management Program policy not to use PPRTV appendix values to develop remediation standards. As the HEAST RfC was developed using the Prendergast study data, the Department decided not to use this RfC in the development of a remediation standard.

[5] A HEAST RfC exists for 1,1-dichloroethane, but a subsequent PPRTV review (2006) indicated that data were inadequate to derive a chronic exposure RfC for 1,1-dichloroethane.

[6] A PPRTV RfC exists for trans-1,2-dichloroethene but a subsequent IRIS assessment (2010) stated "the available inhalation data from the Freund study are insufficient to support reference value derivation and RfC."

[7] A HEAST 1991 IUR exists for styrene but the USEPA NCEA does not recommend its use.

[8] Although an NJDWQI RfC exists for 1,1,1-trichloroethane, the Department determined that the IRIS RfC is a scientifically better toxicity value to develop a non-cancer-based soil inhalation remediation standard.

[9] Although a PPRTV RfC for 1,1,2-trichloroethane exists, it is listed as an appendix value. The PPRTV appendix value is based on a study that was determined by the USEPA to have flaws. It is the Department's Site Remediation and Waste Management Program policy not to use PPRTV appendix values to develop soil remediation standards.

[10] The IRIS RfC for trichloroethene is based on a route-to-route conversion of an ingestion study, which was determined to be acceptable by the USEPA as substantiated by additional evaluation including physiologically-based pharmacokinetic modeling.

[11] A HEAST RfC exists for trichlorofluoromethane, but a subsequent PPRTV review (2009) indicated that data used to derive the RfC were inadequate.

[12] The IRIS RfC for vinyl chloride is based on a route-to-route conversion of an ingestion study, which was determined to be acceptable by the USEPA as substantiated by additional evaluation including physiologically-based pharmacokinetic modeling.

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APPENDIX 12

DERIVATION OF EQUATION EQUIVALENCY USED FOR THE DEVELOPMENT OF SOIL AND INDOOR AIR REMEDIATION STANDARDS

This appendix demonstrates the equivalency between the equations used by the Department in the development of the soil and indoor air remediation standards, and the equations used by the USEPA in the development of soil and indoor air risk-based screening levels. This appendix demonstrates the equivalency for the following Department soil and indoor air remediation standard equations:

- **N.J.A.C. 7:26D Appendix 2, Equation 1, Residential Carcinogenic Ingestion-Dermal Human Health-based Criterion Equation;**
- **N.J.A.C. 7:26D Appendix 2, Equation 2, Residential Noncarcinogenic Ingestion-Dermal Human Health-based Criterion Equation;**
- **N.J.A.C. 7:26D Appendix 2, Equation 3, Nonresidential Carcinogenic Ingestion-Dermal Human Health-based Criterion Equation;**

- **N.J.A.C. 7:26D Appendix 2, Equation 4, Nonresidential Noncarcinogenic Ingestion-Dermal Human Health-based Criterion Equation;**
- **N.J.A.C. 7:26D Appendix 3, Equation 1, Carcinogenic Inhalation Human Health-based Criterion Equation;**
- **N.J.A.C. 7:26D Appendix 3, Equation 2, Noncarcinogenic Inhalation Human Health-based Criterion Equation;**
- **N.J.A.C. 7:26D Appendix 5, Equation 1, Carcinogenic Indoor Air Human Health-based Criterion Equation; and**
- **N.J.A.C. 7:26D Appendix 5, Equation 2, Noncarcinogenic Indoor Air Human Health-based Criterion Equation.**

N.J.A.C. 7:26D Appendix 2, Equation 1 – Residential Carcinogenic Ingestion-Dermal Human Health-Based Criterion Equation

The origin of the Department residential soil remediation standard for the ingestion-dermal exposure pathway for a carcinogen is based upon the USEPA, Regional Screening Levels, Equations (November 2018) (RSLE):

$$SL_{res\text{-}soil\text{-}ca\text{-}tot}\,(mg/kg) = \frac{1}{\frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}ing}} + \frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}der}} + \frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}inh}}}$$

This is the equation used by the USEPA to develop soil contaminant screening levels where the human health risks from the ingestion exposure pathway, the dermal exposure pathway, and the inhalation exposure pathway are combined. However, the soil remediation standards the Department developed only combine the ingestion and dermal exposure pathways and address the inhalation exposure pathway separately. Consequently, the Department modified the USEPA equation listed above by deleting the inhalation related screening level term:

$$\frac{1}{\mathrm{SL}_{\mathrm{res-soil-ca-inh}}}$$

The resulting modified equation represents not the total of the ingestion, dermal, and inhalation exposure components, but just the ingestion and dermal aspects, which is designated:

$$\mathrm{SL}_{\text{res-soil-ca-ing-der}} = \frac{1}{\left(\frac{1}{\mathrm{SL}_{\mathrm{res-soil-ca-ing}}}\right) + \left(\frac{1}{\mathrm{SL}_{\mathrm{res-soil-ca-der}}}\right)}$$

The RSLE states that:

$$\mathrm{SL}_{\text{res-soil-ca-ing}}\left(\mathrm{mg/kg}\right) = \frac{\mathrm{TR}\times\mathrm{AT}_{\mathrm{res}}\left(\frac{365\ \mathrm{days}}{\mathrm{year}}\times\mathrm{LT}\left(70\ \mathrm{years}\right)\right)}{\mathrm{CSF}_{\mathrm{o}}\left(\frac{\mathrm{mg}}{\mathrm{kg\text{-}day}}\right)^{-1}\times\mathrm{RBA}\times\mathrm{IFS}_{\mathrm{res\text{-}adj}}\left(\frac{36{,}750\ \mathrm{mg}}{\mathrm{kg}}\right)\times\left(\frac{10^{-6}\mathrm{kg}}{\mathrm{mg}}\right)}$$

and

$$SL_{res\text{-}soil\text{-}ca\text{-}der}\,(mg/kg) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\ (70\ years)\right)}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right) \times DFS_{res\text{-}adj}\left(\frac{103{,}390\ mg}{kg}\right) \times ABS_d \times \left(\frac{10^{-6}\,kg}{mg}\right)}$$

The above two equations include the units for the listed input parameters. Deleting the units simplify the two equations to:

$$SL_{res\text{-}soil\text{-}ca\text{-}ing} = \frac{TR\ x\ AT_{res}\ x\ LT}{CSF_o\ x\ RBA\ x\ IFS_{res-adj}\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

and

$$SL_{res\text{-}soil\text{-}ca\text{-}der} = \frac{TR\ x\ AT_{res}\ x\ LT}{\left(\frac{CSF_o}{GIABS}\right)\ x\ DFS_{res-adj}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Because $\mathbf{GIABS = \frac{CSF_o}{CSF_d}}$ **the second equation further simplifies to:**

$$SL_{res-soil-ca-der} = \frac{TR\ x\ AT_{res}\ x\ LT}{CSF_d\ x\ DFS_{res-adj}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Starting with the Department-modified base USEPA equation, as described above:

$$SL_{res\text{-}soil\text{-}ca\text{-}ing\text{-}der} = \frac{1}{\left(\frac{1}{SL_{res-soil-ca-ing}}\right) + \left(\frac{1}{SL_{res-soil-ca-der}}\right)}$$

1. Insert the simplified equations for $SL_{res\text{-}soil\text{-}ca\text{-}ing}$ and $SL_{res\text{-}soil\text{-}ca\text{-}der}$ described above into the denominator of the $SL_{res\text{-}soil\text{-}ca\text{-}ing\text{-}derm}$ equation, which then becomes:

$$\frac{1}{\left[\left[\frac{1}{\left(\frac{TR \text{ x } AT_{res} \text{ x } LT}{CSF_o \text{ x } RBA \text{ x } IFS_{res-adj} \text{ x } \left(\frac{10^{-6} \text{ kg}}{mg}\right)}\right)}\right] + \left[\frac{1}{\left(\frac{TR \text{ x } AT_{res} \text{ x } LT}{CSF_d \text{ x } DFS_{res-adj} \text{ x } ABS_d \text{ x } \left(\frac{10^{-6} \text{ kg}}{mg}\right)}\right)}\right]\right]}$$

2. Simplify the reciprocal (in the denominator of the equation immediately above) containing the equivalent expression of $SL_{res\text{-}soil\text{-}ca\text{-}ing}$ by multiplying it by the term:

$$\frac{CSF_o \text{ x } RBA \text{ x } IFS_{res-adj} \text{ x } \left(\frac{10^{-6} \text{ kg}}{mg}\right)}{CSF_o \text{ x } RBA \text{ x } IFS_{res-adj} \text{ x } \left(\frac{10^{-6} \text{ kg}}{mg}\right)}$$

This is the same as multiplying the reciprocal of the expression by 1.

3. Similarly, simplify the reciprocal containing the equivalent expression of $SL_{res\text{-}soil\text{-}ca\text{-}der}$ by multiplying it by the term:

$$\frac{\mathrm{CSF_d\ x\ DFS_{res-adj}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}{\mathrm{CSF_d\ x\ DFS_{res-adj}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}$$

Again, this is effectively multiplying by 1.

4. This results in the expression:

$$\frac{1}{\left(\frac{\mathrm{CSF_o\ x\ RBA\ x\ IFS_{res-adj}\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}{\mathrm{TR\ x\ AT_{res}\ x\ LT}}\right) + \left(\frac{\mathrm{CSF_d\ x\ DFS_{res-adj}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}{\mathrm{TR\ x\ AT_{res}\ x\ LT}}\right)}$$

5. After separating the common term ($\frac{10^{-6}\ kg}{mg}$) from both expressions in the denominator, multiply both the numerator and the denominator of the entire equation by the expression:

$$\mathrm{TR\ x\ AT_{res}\ x\ LT}$$

Performing steps 1 through 5 above results in the following expression:

$SL_{res\text{-}soil\text{-}ca\text{-}ing\text{-}derm}$ =

$$\frac{\mathrm{TR\ x\ AT_{res}\ x\ LT}}{\left(\frac{10^{-6}\ kg}{mg}\right)\ x\ \left[\left(\mathrm{CSF_o\ x\ RBA\ x\ IFS_{res-adj}}\right) + \left(\mathrm{CSF_d\ x\ DFS_{res-adj}\ x\ ABS_d}\right)\right]}$$

This USEPA terminology (immediately above), which is for a residential land use scenario involving a carcinogenic contaminant, converts to the Department terminology as follows:

USEPA Term	Department Term	USEPA Definition
TR	***TR***	**Target cancer risk**
AT_{res}	***AT***	**Averaging time**
LT	***LT***	**Lifetime**
CSF_o	***CSF_o***	**Oral cancer slope factor**
RBA	**None**	**Relative Bio-availability**
$IFS_{res\text{-}adj}$	***IFS_{adj}***	**Age-adjusted soil ingestion rate**
CSF_d	***CSF_D***	**Dermal cancer slope factor**
$DFS_{res\text{-}adj}$	***DFS_{adj}***	**Age-adjusted soil dermal contact factor**
ABS_d	***ABS_d***	**Dermal absorption fraction**
$\frac{10^{-6}\ \mathrm{kg}}{\mathrm{mg}}$	$\frac{10^{-6} kg}{mg}$	**Unit conversion factor**
GIABS	***GIABS***	**Gastro-intestinal absorption fraction**

Using the above terminology to translate this equation into Departmental nomenclature, the equation becomes:

$$IDc = \frac{TR \ x \ AT \ x \ LT}{\left(\frac{10^{-6}\ kg}{mg}\right) \ x \ \left[\left(CSF_O \ x \ IFS_{adj}\right) + \left(CSF_D \ x \ DFS_{adj} \ x \ ABS_d\right)\right]}$$

Note that the USEPA term $SL_{res\text{-}soil\text{-}ca\text{-}ing\text{-}derm}$ is the equivalent of the Department term ID_c. In addition, there is no Department RBA parameter because the value is usually 1. Consequently, an RBA parameter does not appear in the translated equation. The equation presented immediately above is equivalent to the Department equation presented in N.J.A.C. 7:26D Appendix 2 as Equation 1 and verifies its equivalence with equations used by the USEPA.

N.J.A.C. 7:26D Appendix 2, Equation 1 is:

$$ID_c = \frac{TR * AT * LT}{(10^{-6} kg/mg) * [(CSF_O * IFS_{adj}) + (CSF_D * DFS_{adj} * ABS_d)]}$$

<u>N.J.A.C. 7:26D Appendix 2, Equation 2 – Residential Noncarcinogenic Ingestion-Dermal Human Health-Based Criteria Equation</u>

The origin of the Department residential soil remediation standard for the ingestion-dermal exposure pathway for a noncarcinogen is based upon the USEPA, Regional Screening Levels, Equations (November 2018) (RSLE):

$$SL_{res\text{-}soil\text{-}nc\text{-}tot\text{-}c}\ (mg/kg) = \frac{1}{\frac{1}{SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}c}} + \frac{1}{SL_{res\text{-}soil\text{-}nc\text{-}der\text{-}c}} + \frac{1}{SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}c}}}$$

This is the equation used by the USEPA to develop soil contaminant screening levels where the human health risks from the ingestion exposure pathway, the dermal exposure pathway, and the inhalation exposure pathway are combined. However, the soil remediation standards the Department developed only combine the ingestion and dermal exposure pathways and address the inhalation exposure pathway separately. Consequently, the Department modified the USEPA equation listed above by deleting the inhalation related screening level term:

$$\frac{1}{\mathrm{SL}_{\mathrm{res-soil-nc-inh-c}}}$$

The resulting modified equation represents not the total of the ingestion, dermal, and inhalation exposure components, but just the ingestion and dermal aspects, which is designated:

$$\mathrm{SL}_{\text{res-soil-nc-ing-der-c}} = \frac{1}{\left(\frac{1}{\mathrm{SL}_{\mathrm{res-soil-nc-ing-c}}}\right) + \left(\frac{1}{\mathrm{SL}_{\mathrm{res-soil-nc-der-c}}}\right)}$$

The Department calculation of the residential noncarcinogenic ingestion-dermal criterion is based on a child exposure scenario. As such, the RSLE states that:

$$\mathrm{SL}_{\text{res-soil-nc-ing-c}}\,(\mathrm{mg/kg}) = \frac{\mathrm{THQ}\times\mathrm{AT}_{\text{res-c}}\left(\frac{365\ \mathrm{days}}{\mathrm{year}}\times\mathrm{ED}_{\text{res-c}}\,(6\ \mathrm{years})\right)\times\mathrm{BW}_{\text{res-c}}\,(15\ \mathrm{kg})}{\mathrm{EF}_{\text{res-c}}\left(\frac{350\ \mathrm{days}}{\mathrm{year}}\right)\times\mathrm{ED}_{\text{res-c}}\,(6\ \mathrm{years})\times\frac{\mathrm{RBA}}{\mathrm{RfD}_{\mathrm{o}}\left(\frac{\mathrm{mg}}{\mathrm{kg\text{-}day}}\right)}\times\mathrm{IRS}_{\text{res-c}}\left(\frac{200\ \mathrm{mg}}{\mathrm{day}}\right)\times\frac{10^{-6}\mathrm{kg}}{1\,\mathrm{mg}}}$$

and

$$SL_{res\text{-}soil\text{-}nc\text{-}der\text{-}c}\left(mg/kg\right) = \frac{THQ \times AT_{res\text{-}c}\left(\frac{365\ days}{year}\right) \times ED_{res\text{-}c}\left(6\ years\right) \times BW_{res\text{-}c}\left(15\ kg\right)}{EF_{res\text{-}c}\left(\frac{350\ days}{year}\right) \times ED_{res\text{-}c}\left(6\ years\right) \times \frac{1}{\left(RfD_o\left(\frac{mg}{kg\text{-}day}\right) \times GIABS\right)} \times SA_{res\text{-}c}\left(\frac{2373\ cm^2}{day}\right) \times AF_{res\text{-}c}\left(\frac{0.2\ mg}{cm^2}\right) \times ABS_d \times \frac{10^{-6}kg}{1mg}}$$

The above two equations include the units for the listed input parameters. Deleting the units simplify the two equations to:

$$SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}c} = \frac{THQ\ x\ AT_{res-c}\ x\ ED_{res-c}\ x\ BW_{res-c}}{EF_{res-c}\ x\ ED_{res-c}\ x\ \left(\frac{RBA}{RDO_0}\right)\ x\ IRS\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

and

$$SL_{res\text{-}soil\text{-}nc\text{-}der\text{-}c} = \frac{THQ\ x\ AT_{res-c}\ x\ ED_{res-c}\ x\ BW_{res-c}}{EF_{res-c}\ x\ ED_{res-c}\ x\ \left(\frac{1}{RfD_0\ x\ GIABS}\right)\ x\ SA_{res-c}\ x\ AF_{res-c}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Because GIABS = $\frac{RfD_D}{RfD_o}$ the second equation further simplifies to:

$$SL_{res\text{-}soil\text{-}nc\text{-}der\text{-}c} = \frac{THQ\ x\ AT_{res-c}\ x\ ED_{res-c}\ x\ BW_{res-c}}{EF_{res-c}\ x\ ED_{res-c}\ x\ \left(\frac{1}{RfD_D}\right)\ x\ SA_{res-c}\ x\ AF_{res-c}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Starting with the Department-modified base USEPA equation, as described above:

$$SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}der\text{-}c} = \frac{1}{\left(\frac{1}{SL_{res-soil-nc-ing-c}}\right) + \left(\frac{1}{SL_{res-soil-nc-der-c}}\right)}$$

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1. Insert the simplified equations for $SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}c}$ and $SL_{res\text{-}soil\text{-}nc\text{-}der\text{-}c}$ described above into the denominator of the $SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}der\text{-}c}$ equation, which then becomes:

$SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}der\text{-}c}$ =

$$\frac{1}{\left[\left[\frac{1}{\left(\frac{THQ \text{ x } AT_{res-c} \text{ x } ED_{res-c} \text{ x } BW_{res-c}}{EF_{res-c} \text{ x } ED_{res-c} \text{ x } \left(\frac{RBA}{RDO_0}\right) \text{ x } IRS \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}\right)}\right] + \left[\frac{1}{\left(\frac{THQ \text{ x } AT_{res-c} \text{ x } ED_{res-c} \text{ x } BW_{res-c}}{EF_{res-c} \text{ x } ED_{res-c} \text{ x } \left(\frac{1}{RfD_D}\right) \text{ x } SA_{res-c} \text{ x } AF_{res-c} \text{ x } ABS_d \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}\right)}\right]\right]}$$

2. Simplify the reciprocals in the denominator of the equation immediately above (similar to what was done in the derivation of N.J.A.C. 7:26D Appendix 2, Equation 1 above) using the respective terms:

$$\frac{EF_{res-c} \text{ x } ED_{res-c} \text{ x } \left(\frac{RBA}{RDO_0}\right) \text{ x } IRS \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}{EF_{res-c} \text{ x } ED_{res-c} \text{ x } \left(\frac{RBA}{RDO_0}\right) \text{ x } IRS \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}$$

and

$$\frac{EF_{res-c} \text{ x } ED_{res-c} \text{ x } \left(\frac{1}{RfD_D}\right) \text{ x } SA_{res-c} \text{ x } AF_{res-c} \text{ x } ABS_d \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}{EF_{res-c} \text{ x } ED_{res-c} \text{ x } \left(\frac{1}{RfD_D}\right) \text{ x } SA_{res-c} \text{ x } AF_{res-c} \text{ x } ABS_d \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}$$

Again, this is the same as multiplying each of the reciprocals in the equation denominator by

1.

3. This results in the following:

$$SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}der\text{-}c} =$$

$$\frac{1}{\left(\frac{EF_{res-c}\ x\ ED_{res-c}\ x\ \left(\frac{RBA}{RfD_0}\right)\ x\ IRS\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}{THQ\ x\ AT_{res-c}\ x\ ED_{res-c}\ x\ BW_{res-c}}\right) + \left(\frac{EF_{res-c}\ x\ ED_{res-c}\ x\ \left(\frac{1}{RfD_D}\right)\ x\ SA_{res-c}\ x\ AF_{res-c}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}{THQ\ x\ AT_{res-c}\ x\ ED_{res-c}\ x\ BW_{res-c}}\right)}$$

4. After separating out the common terms ($\frac{10^{-6}\ kg}{mg}$) and ($EF_{res-c}\ x\ ED_{res-c}$) from both expressions in the denominator, multiply both the numerator and the denominator of the entire equation by the expression:

$$THQ\ x\ AT_{res-c}\ x\ ED_{res-c}\ x\ BW_{res-c}$$

Performing steps 1 through 4 above results in the following expression:

$$SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}der\text{-}c} =$$

$$\frac{THQ\ x\ AT_{res-c}\ x\ ED_{res-c}\ x\ BW_{res-c}}{\left[\left(\left(\frac{RBA}{RfD_0}\right)\ x\ IRS\right) + \left(\left(\frac{1}{RfD_D}\right)\ x\ SA_{res-c}\ x\ AF_{res-c}\ x\ ABS_d\right)\right]\ x\ (EF_{res-c}\ x\ ED_{res-c}\ )\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

This USEPA terminology (immediately above), which is for a residential land use scenario involving a noncarcinogenic contaminant, converts to the Department terminology as follows:

USEPA Term	Department Term	USEPA Definition
THQ	***THQ***	**Target hazard quotient**
$AT_{res\text{-}c}$	***AT***	**Averaging time**
$EF_{res\text{-}c}$	***EF***	**Exposure frequency – child**
$BW_{res\text{-}c}$	$\mathcal{BW}$	**Body weight - child**
$ED_{res\text{-}c}$	***ED***	**Exposure duration - child**
RBA	**None**	**Relative Bio-availability**
RfD_o	RfD_o	**Oral reference dose**
IRS	***IR***	**Soil ingestion rate - child**
RfD_D	RfD_D	**Dermal reference dose**
$SA_{res\text{-}c}$	***SA***	**Skin surface area - child**
$AF_{res\text{-}c}$	***AF***	**Soil adherence factor - child**
ABS_d	ABS_d	**Dermal absorption fraction**
$\frac{10^{-6}\ \mathrm{kg}}{\mathrm{mg}}$	$\frac{10^{-6}\mathrm{kg}}{\mathrm{mg}}$	**Unit conversion factor**
GIABS	***GIABS***	**Gastro-intestinal absorption fraction**

Using the above terminology to translate this equation into Departmental nomenclature, the equation becomes:

$SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}der\text{-}c}$ =

$$\frac{THQ \ x \ AT \ x \ ED \ x \ BW}{(EF \ x \ ED) \ x \ \left(\frac{10^{-6} \ kg}{mg}\right) \ x \left[\left(\left(\frac{1}{RfD_0}\right) \ x \ IR\right) + \left(\frac{1}{RfD_D} \ x \ SA \ x \ AF \ x \ ABS_d\right)\right]}$$

Note that the USEPA term $SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}der\text{-}c}$ is the equivalent of the Department term ID_{nc}.

In addition, there is no Department RBA parameter because the value is usually 1. Consequently, an RBA parameter does not appear in the translated equation. The equation presented immediately above is equivalent to the Department equation presented in N.J.A.C. 7:26D Appendix 2 as Equation 2 and verifies its equivalence with equations used by the USEPA.

N.J.A.C. 7:26d Appendix 2, Equation 2 is:

$$ID_{nc} = \frac{THQ * AT * ED * BW}{(EF * ED * 10^{-6} kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$$

N.J.A.C. 7:26D Appendix 2, Equation 3 – Nonresidential Carcinogenic Ingestion-Dermal Human Health-Based Criteria

The origin of the Department nonresidential soil remediation standard for the ingestion-dermal exposure pathway for a carcinogen is based upon the USEPA, Regional Screening Levels, Equations (November 2018) (RSLE):

$$SL_{ow\text{-}soil\text{-}ca\text{-}tot}\,(mg/kg) = \frac{1}{\frac{1}{SL_{ow\text{-}soil\text{-}ca\text{-}ing}} + \frac{1}{SL_{ow\text{-}soil\text{-}ca\text{-}der}} + \frac{1}{SL_{ow\text{-}soil\text{-}ca\text{-}inh}}}$$

This is the equation used by the USEPA to develop soil contaminant screening levels where the human health risks from the ingestion exposure pathway, the dermal exposure pathway, and the inhalation exposure pathway are combined. However, the soil remediation standards the Department developed only combine the ingestion and dermal exposure pathways and address the inhalation exposure pathway separately. Consequently, the Department modified the USEPA equation listed above by deleting the inhalation related screening level term:

$$\frac{1}{SL_{ow-soil-ca-inh}}$$

The resulting modified equation represents not the total of the ingestion, dermal, and inhalation exposure components, but just the ingestion and dermal aspects, which is designated:

$$SL_{ow\text{-}soil\text{-}ca\text{-}ing\text{-}der} = \frac{1}{\left(\frac{1}{SL_{ow-soil-ca-ing}}\right) + \left(\frac{1}{SL_{ow-soil-ca-der}}\right)}$$

The Department calculation of the nonresidential carcinogenic ingestion-dermal criterion is based on an adult outdoor worker exposure scenario.

As such, the RSLE states:

$$SL_{ow\text{-}soil\text{-}ca\text{-}ing}\left(mg/kg\right) = \frac{TR \times AT_{ow}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times BW_{ow}\left(80\ kg\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times RBA \times IR_{ow}\left(100\ \frac{mg}{day}\right) \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

and

$$SL_{ow\text{-}soil\text{-}ca\text{-}der}\left(mg/kg\right) = \frac{TR \times AT_{ow}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times BW_{ow}\left(80\ kg\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times \left(\frac{CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right) \times SA_{ow}\left(\frac{3527\ cm^{2}}{day}\right) \times AF_{ow}\left(\frac{0.12\ mg}{cm^{2}}\right) \times ABS_{d} \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

The above two equations include the units for the listed input parameters. Deleting the units simplify the two equations to:

$$SL_{ow\text{-}soil\text{-}ca\text{-}ing} = \frac{TR\ x\ AT_{ow}\ x\ LT\ x\ BW_{ow}}{EF_{ow}\ x\ ED_{ow}\ x\ CSF_{o}\ x\ RBA\ x\ IR_{ow}\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

and

$$SL_{ow\text{-}soil\text{-}ca\text{-}der} = \frac{TR\ x\ AT_{ow}\ x\ LT\ x\ BW_{ow}}{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{CSF_{o}}{GIABS}\right)\ x\ SA_{ow}\ x\ AF_{ow}\ x\ ABS_{d}\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Because GIABS = $\frac{CSF_o}{CSF_D}$ the second equation further simplifies to:

$$SL_{ow\text{-}soil\text{-}ca\text{-}der} = \frac{TR \times AT_{ow} \times LT \times BW_{ow}}{EF_{ow} \times ED_{ow} \times CSF_D \times SA_{ow} \times AF_{ow} \times ABS_d \times \left(\frac{10^{-6}\,kg}{mg}\right)}$$

Starting with the Department-modified base USEPA equation, as described above:

$$SL_{ow\text{-}soil\text{-}ca\text{-}ing\text{-}der} = \frac{1}{\left(\frac{1}{SL_{ow-soil-ca-ing}}\right) + \left(\frac{1}{SL_{ow-soil-ca-der}}\right)}$$

1. Insert the simplified equations for $SL_{ow\text{-}soil\text{-}ca\text{-}ing}$ and $SL_{ow\text{-}soil\text{-}ca\text{-}der}$ described above into the denominator of the $SL_{ow\text{-}soil\text{-}ca\text{-}ing\text{-}der}$ equation, which then becomes:

$$SL_{ow\text{-}soil\text{-}ca\text{-}ing\text{-}der} =$$

$$\frac{1}{\left[\left[\frac{1}{\left(\frac{TR \times AT_{ow} \times LT \times BW_{ow}}{EF_{ow} \times ED_{ow} \times CSF_o \times RBA \times IR_{ow} \times \left(\frac{10^{-6}\,kg}{mg}\right)}\right)}\right] + \left[\frac{1}{\left(\frac{TR \times AT_{ow} \times LT \times BW_{ow}}{EF_{ow} \times ED_{ow} \times CSF_D \times SA_{ow} \times AF_{ow} \times ABS_d \times \left(\frac{10^{-6}\,kg}{mg}\right)}\right)}\right]\right]}$$

2. Simplify the reciprocals in the equation denominator immediately above (similar to what was done in the derivation of N.J.A.C. 7:26D Appendix 2, Equation 1 above) using the respective terms:

$$\frac{EF_{ow} \text{ x } ED_{ow} \text{ x } CSF_o \text{ x } RBA \text{ x } IR_{ow} \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}{EF_{ow} \text{ x } ED_{ow} \text{ x } CSF_o \text{ x } RBA \text{ x } IR_{ow} \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}$$

and

$$\frac{EF_{ow} \text{ x } ED_{ow} \text{ x } CSF_D \text{ x } SA_{ow} \text{ x } AF_{ow} \text{ x } ABS_d \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}{EF_{ow} \text{ x } ED_{ow} \text{ x } CSF_D \text{ x } SA_{ow} \text{ x } AF_{ow} \text{ x } ABS_d \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}$$

Again, this is the same as multiplying the reciprocals in the equation denominator by 1.

3. This results in the following:

$SL_{ow\text{-}soil\text{-}ca\text{-}ing\text{-}der}$ =

$$\frac{1}{\left(\frac{EF_{ow} \text{ x } ED_{ow} \text{ x } CSF_o \text{ x } RBA \text{ x } IR_{ow} \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}{TR \text{ x } AT_{ow} \text{ x } LT \text{ x } BW_{ow}}\right) + \left(\frac{EF_{ow} \text{ x } ED_{ow} \text{ x } CSF_D \text{ x } SA_{ow} \text{ x } AF_{ow} \text{ x } ABS_d \text{ x } \left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)}{TR \text{ x } AT_{ow} \text{ x } LT \text{ x } BW_{ow}}\right)}$$

4. After separating out the common terms $(EF_{ow} \text{ x } ED_{ow})$ and $\left(\frac{10^{-6}\text{ kg}}{\text{mg}}\right)$ from both expressions in the denominator, multiply both the numerator and the denominator of the entire equation by the expression:

$$\mathrm{TR\ x\ AT_{ow}\ x\ LT\ x\ BW_{ow}}$$

Performing steps 1 through 4 above results in the following expression:

$SL_{ow\text{-}soil\text{-}ca\text{-}ing\text{-}der}$ =

$$\frac{\mathrm{TR\ x\ AT_{ow}\ x\ LT\ x\ BW_{ow}}}{(\mathrm{EF_{ow}\ x\ ED_{ow}})\ \mathrm{x}\left(\frac{10^{-6}\ \mathrm{kg}}{\mathrm{mg}}\right)\mathrm{x}\left((\mathrm{CSF_o\ x\ RBA\ x\ IR_{ow}})+(\mathrm{CSF_D\ x\ SA_{ow}\ x\ AF_{ow}\ x\ ABS_d})\right)}$$

This USEPA terminology (immediately above), which is for a nonresidential land use scenario involving a carcinogenic contaminant, converts to the Department terminology as follows:

USEPA Term	Department Term	USEPA Definition
TR	***TR***	**Target cancer risk**
AT_{ow}	***AT***	**Averaging time - outdoor worker**
LT	***LT***	**Lifetime**
CSF_o	***CSF_o***	**Oral cancer slope factor**
RBA	**None**	**Relative Bio-availability**
IR_{ow}	***IR***	**Soil ingestion rate – outdoor worker**
CSF_d	***CSF_D***	**Dermal cancer slope factor**
AF_{ow}	***AF***	**Soil adherence factor – outdoor worker**
ABS_d	***ABS_d***	**Dermal absorption fraction**
$\frac{10^{-6}\ \mathrm{kg}}{\mathrm{mg}}$	$\frac{10^{-6} kg}{mg}$	**Unit conversion factor**

GIABS ***GIABS*** **Gastro-intestinal absorption fraction**

Using the above terminology to translate this equation into Departmental nomenclature, the equation becomes:

$$SL_{\text{low-soil-ca-ing-der}} = \frac{TR\ x\ AT\ x\ LT\ x\ BW}{(EF\ x\ ED)\ x\ \left(\frac{10^{-6}\ kg}{mg}\right) x\ \left((CSF_O\ x\ IR) + (\ CSF_D\ x\ SA\ x\ AF\ x\ ABS_d)\right)}$$

Note that the USEPA term $SL_{\text{low-soil-ca-ing-der}}$ is the equivalent of the Department term ID_c. In addition, there is no Department RBA parameter because the value is usually 1. Consequently, an RBA parameter does not appear in the translated equation. The equation presented immediately above is equivalent to the Department equation presented in N.J.A.C. 7:26D Appendix 2 as Equation 3 and verifies its equivalence with equations used by the USEPA.

N.J.A.C. 7:26D Appendix 2, Equation 3 is:

$$ID_c = \frac{TR * AT * LT * BW}{EF * ED * 10^{-5}\ kg/mg * [(CSF_O * IR) + (CSF_D * SA * AF * ABS_d)]}$$

<u>N.J.A.C. 7:26D Appendix 2, Equation 4 – Nonresidential Noncarcinogenic Ingestion-Dermal Human Health-Based Criteria</u>

The origin of the Department nonresidential soil remediation standard for the ingestion-dermal exposure pathway for a noncarcinogen is based upon the USEPA, Regional Screening Levels, Equations (November 2018) (RSLE):

$$SL_{ow\text{-}soil\text{-}nc\text{-}tot}\,(mg/kg) = \frac{1}{\frac{1}{SL_{ow\text{-}soil\text{-}nc\text{-}ing}} + \frac{1}{SL_{ow\text{-}soil\text{-}nc\text{-}der}} + \frac{1}{SL_{ow\text{-}soil\text{-}nc\text{-}inh}}}$$

This is the equation used by the USEPA to develop soil contaminant screening levels where the human health risks from the ingestion exposure pathway, the dermal exposure pathway, and the inhalation exposure pathway are combined. However, the soil remediation standards the Department developed only combine the ingestion and dermal exposure pathways and address the inhalation exposure pathway separately. Consequently, the Department modified the USEPA equation listed above by deleting the inhalation related screening level term:

$$\frac{1}{SL_{ow-soil-nc-inh}}$$

The resulting modified equation represents not the total of the ingestion, dermal, and inhalation exposure components, but just the ingestion and dermal aspects, which is designated:

$$SL_{ow\text{-}soil\text{-}nc\text{-}ing\text{-}der} = \frac{1}{\left(\frac{1}{SL_{ow-soil-nc-ing}}\right) + \left(\frac{1}{SL_{ow-soil-nc-der}}\right)}$$

The Department calculation of the nonresidential noncarcinogenic ingestion-dermal criterion is based on an adult outdoor worker exposure scenario. As such, the RSLE states:

$$SL_{ow\text{-}soil\text{-}nc\text{-}ing}\left(mg/kg\right) = \frac{THQ \times AT_{ow\text{-}a}\left(\frac{365\ days}{year} \times ED_{ow}\left(25\ years\right)\right) \times BW_{ow}\left(80\ kg\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times \frac{RBA}{RfD_o\left(\frac{mg}{kg\text{-}day}\right)} \times IR_{ow}\left(100\ \frac{mg}{day}\right) \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

and

$$SL_{ow\text{-}soil\text{-}nc\text{-}der}\left(mg/kg\right) = \frac{THQ \times AT_{ow\text{-}a}\left(\frac{365\ days}{year} \times ED_{ow}\left(25\ years\right)\right) \times BW_{ow}\left(80\ kg\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times \left(\frac{1}{RfD_o\left(\frac{mg}{kg\text{-}day}\right) \times GIABS}\right) \times SA_{ow}\left(\frac{3527\ cm^2}{day}\right) \times AF_{ow}\left(\frac{0.12\ mg}{cm^2}\right) \times ABS_d \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

The above two equations include the units for the listed input parameters. Deleting the units simplify the two equations to:

$$SL_{ow\text{-}soil\text{-}nc\text{-}ing} = \frac{THQ\ x\ AT_{ow}\ x\ ED_{ow}\ x\ BW_{ow}}{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{RBA}{RfD_o}\right)\ x\ IR_{ow}\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

and

$$SL_{ow\text{-}soil\text{-}nc\text{-}der} = \frac{THQ\ x\ AT_{ow}\ x\ ED_{ow}\ x\ BW_{ow}}{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{1}{RfD_o\ x\ GIABS}\right)\ x\ SA_{ow}\ x\ AF_{ow}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Because GIABS = $\frac{\mathbf{RfD_D}}{\mathbf{RfD_o}}$ the second equation further simplifies to:

$$SL_{ow\text{-}soil\text{-}nc\text{-}der} = \frac{THQ \times AT_{ow} \times ED_{ow} \times BW_{ow}}{EF_{ow} \times ED_{ow} \times \left(\frac{1}{RfD_D}\right) \times SA_{ow} \times AF_{ow} \times ABS_d \times \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Starting with the Department-modified base USEPA equation, as described above:

1. Insert the simplified equations for $SL_{ow\text{-}soil\text{-}nc\text{-}ing}$ and $SL_{ow\text{-}soil\text{-}nc\text{-}der}$ described above into the denominator of the $SL_{ow\text{-}soil\text{-}nc\text{-}ing\text{-}der}$ equation which then becomes:

$SL_{ow\text{-}soil\text{-}nc\text{-}ing\text{-}der}$ =

$$\frac{1}{\left[\left[\frac{1}{\left(\frac{THQ \times AT_{ow} \times ED_{ow} \times BW_{ow}}{EF_{ow} \times ED_{ow} \times \left(\frac{RBA}{RfD_o}\right) \times IR_{ow} \times \left(\frac{10^{-6}\ kg}{mg}\right)}\right)}\right] + \left[\frac{1}{\left(\frac{THQ \times AT_{ow} \times ED_{ow} \times BW_{ow}}{EF_{ow} \times ED_{ow} \times \left(\frac{1}{RfD_D}\right) \times SA_{ow} \times AF_{ow} \times ABS_d \times \left(\frac{10^{-6}\ kg}{mg}\right)}\right)}\right]\right]}$$

2. Simplify the reciprocals in the equation denominator immediately above (similar to what was done in the derivation of N.J.A.C. 7:26D Appendix 2, Equation 1 above) using the respective terms:

$$\frac{\mathrm{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{RBA}{RfD_o}\right)\ x\ IR_{ow}\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}{\mathrm{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{RBA}{RfD_o}\right)\ x\ IR_{ow}\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}$$

and

$$\frac{\mathrm{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{1}{RfD_D}\right)\ x\ SA_{ow}\ x\ AF_{ow}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}{\mathrm{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{1}{RfD_D}\right)\ x\ SA_{ow}\ x\ AF_{ow}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}$$

Again, this is the same as multiplying each of the reciprocals in the equation denominator by

1.

3. This results in the following:

$SL_{ow\text{-}soil\text{-}nc\text{-}ing\text{-}der}$ =

$$\frac{1}{\left(\frac{\mathrm{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{RBA}{RfD_o}\right)\ x\ IR_{ow}\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}{\mathrm{THQ\ x\ AT_{ow}\ x\ ED_{ow}\ x\ BW_{ow}}}\right) + \left(\frac{\mathrm{EF_{ow}\ x\ ED_{ow}\ x\ \left(\frac{1}{RfD_D}\right)\ x\ SA_{ow}\ x\ AF_{ow}\ x\ ABS_d\ x\ \left(\frac{10^{-6}\ kg}{mg}\right)}}{\mathrm{THQ\ x\ AT_{ow}\ x\ ED_{ow}\ x\ BW_{ow}}}\right)}$$

4. After separating out the common terms ($\frac{10^{-6}\ kg}{mg}$) and ($EF_{ow}\ x\ ED_{ow}$) from both expressions in the denominator, multiply both the numerator and the denominator of the entire equation by the term:

$$\text{THQ x } \text{AT}_{\text{ow}} \text{ x } \text{ED}_{\text{ow}} \text{ x } \text{BW}_{\text{ow}}$$

Performing steps 1 through 4 above results in the following expression:

SLow-soil-nc-ing-der =

$$\frac{\text{THQ x } \text{AT}_{\text{ow}} \text{ x } \text{ED}_{\text{ow}} \text{ x } \text{BW}_{\text{ow}}}{(\text{EF}_{\text{ow}} \text{ x } \text{ED}_{\text{ow}}) \text{ x } \left(\frac{10^{-6}\ \text{kg}}{\text{mg}}\right) \left[\left(\left(\frac{\text{RBA}}{\text{RfD}_{\text{O}}}\right) \text{ x } \text{IR}_{\text{ow}}\right) + \left(\left(\frac{1}{\text{RfD}_{\text{D}}}\right) \text{ x } \text{SA}_{\text{ow}} \text{ x } \text{AF}_{\text{ow}} \text{ x } \text{ABS}_{\text{d}}\right)\right]}$$

This USEPA terminology (immediately above), which is for a nonresidential land use scenario involving a noncarcinogenic contaminant, converts to the Department terminology as follows:

USEPA Term	Department Term	USEPA Definition
THQ	***THQ***	**Target hazard quotient**
AT_{ow}	***T***	**Averaging time – outdoor worker**
EF_{ow}	***EF***	**Exposure frequency – outdoor worker**
BW_{ow}	***BW***	**Body weight – outdoor worker**
ED_{ow}	***ED***	**Exposure duration – outdoor worker**
RBA	**None**	**Relative Bio-availability**
RfD_o	***RfD_o***	**Oral reference dose**
IR_{ow}	***IR***	**Soil ingestion rate – outdoor worker**
RfD_D	***RfD_D***	**Dermal reference dose**
SA_{ow}	***SA***	**Skin surface area – outdoor worker**

AF_{ow}	***AF***	**Soil adherence factor – outdoor worker**
ABS_d	***ABS_d***	**Dermal absorption fraction**
$\frac{10^{-6}\ \mathrm{kg}}{\mathrm{mg}}$	$\frac{10^{-6} kg}{mg}$	**Unit conversion factor**
GIABS	***GIABS***	**Gastro-intestinal absorption fraction**

Using the above terminology to translate this equation into Departmental nomenclature, the equation becomes:

$$SL_{ow\text{-}soil\text{-}nc\text{-}ing\text{-}der} = \frac{THQ\ x\ AT\ x\ ED\ x\ BW}{(EF\ x\ ED)\ x\ \left(\frac{10^{-6}\ kg}{mg}\right) x\ \left(\left(\frac{1}{RfD_O}\ x\ IR\right) + \left(\frac{1}{RfD_D}\ x\ SA\ x\ AF\ x\ ABS_d\right)\right)}$$

Note that the USEPA term $SL_{ow\text{-}soil\text{-}nc\text{-}ing\text{-}der}$ is the equivalent if the Department term ID_{nc}. In addition, there is no Department RBA parameter because the value is usually 1. Consequently, an RBA parameter does not appear in the translated equation. The equation presented immediately above is equivalent to the Department equation presented at N.J.A.C. 7:26D Appendix 2 as Equation 4 and verifies its equivalence with equations used by the USEPA.

N.J.A.C. 7:26D Appendix 2, Equation 4 is:

$$ID_{nc} = \frac{THQ * AT * ED * BW}{(EF * ED * 10^{-6} kg/mg) * [(\frac{1}{RfD_O} * IR) + (\frac{1}{RfD_D} * SA * AF * ABS_d)]}$$

N.J.A.C. 7:26D Appendix 3, Equation 1 – Carcinogenic Inhalation Human Health-Based Criteria

The Department addresses both residential and nonresidential land uses in calculating the carcinogenic-based inhalation exposure pathway soil criteria by applying the appropriate exposure assumptions. The equivalency demonstration made here uses the residential land use scenario equation and terminology as the specific example. The same equivalency logic also applies to the nonresidential land use scenario.

The origin of the Department residential soil remediation standard for the inhalation exposure pathway for a carcinogen is based upon the USEPA, Regional Screening Levels, Equations (November 2018) (RSLE):

$$SL_{res\text{-}soil\text{-}ca\text{-}tot}\,(mg/kg) = \frac{1}{\frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}ing}} + \frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}der}} + \frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}inh}}}$$

This is the equation used by the USEPA to develop soil contaminant screening levels where the human health risks from the ingestion exposure pathway, the dermal exposure pathway, and the inhalation exposure pathway are combined. However, the soil remediation standards the

Department developed only combine the ingestion and dermal exposure pathways and address the inhalation exposure pathway separately. Consequently, the Department modified the USEPA equation listed above by isolating the inhalation related screening level term:

$$\frac{1}{SL_{res-soil-ca-inh-a}}$$

The resulting modified equation represents not the total of the ingestion, dermal, and inhalation exposure components, but just the inhalation aspect, which is designated:

$$SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}a} = \frac{1}{\left(\frac{1}{SL_{res-soil-nc-inh-a}}\right)} = SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}a}$$

The RSLE states that:

$$SL_{res\text{-}soil\text{-}ca\text{-}inh}\,(mg/kg) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\,(70\ years)\right)}{IUR\left(\frac{\mu g}{m^3}\right)^{-1} \times \left(\frac{1000\ \mu g}{mg}\right) \times EF_{res}\left(\frac{350\ days}{year}\right) \times \left(\frac{1}{VF_{ulim}\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right) \times ED_{res}\,(26\ years) \times ET_{res}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right)}$$

The above equation includes the units for the listed input parameters. Deleting the units simplifies the equation to:

$$SL_{res\text{-}soil\text{-}ca\text{-}inh} = \frac{TR \times AT_{res} \times LT}{IUR \times \left(\frac{1000\ ug}{mg}\right) \times EF_{res} \times \left[\frac{1}{VF_{ulim}} + \frac{1}{PEF}\right] \times ED_{res} \times ET_{res} \times \left(\frac{1\ day}{24\ hours}\right)}$$

This USEPA terminology, which is for a residential land use scenario involving a carcinogenic contaminant, converts to the Department terminology as follows:

USEPA Term	**Department Term**	**USEPA Definition**
TR	***TR***	**Target cancer risk**
AT_{res}	***AT***	**Averaging time - residential**
LT	***LT***	**Lifetime**
IUR	***IUR***	**Inhalation unit risk factor**
EF_{res}	***EF***	**Exposure frequency - residential**
VF_{ulim}	***VF***	**Soil-to-air volatilization factor**
PEF	***PEF***	**Particulate emission factor**
EDres	***ED***	**Exposure duration - residential**
ETres	***ET***	**Exposure time - residential**
$\frac{1000\ \text{ug}}{\text{mg}}$	$\frac{1000\ ug}{mg}$	**Unit conversion factor**
$\frac{1\ \text{day}}{24\ \text{hours}}$	$\frac{1\ day}{24\ hours}$	**Unit conversion factor**

Using the above terminology to translate this equation into Departmental nomenclature, the equation becomes:

$$SL_{\text{res-soil-ca -inh}} = \frac{TR\ x\ AT\ x\ LT}{IUR\ x\ \left(\frac{1000\ ug}{mg}\right)\ x\ EF\ x\ \left\lfloor\frac{1}{VF}+\frac{1}{PEF}\right\rfloor\ x\ ED\ x\ ET\ x\ \left(\frac{1\ day}{24\ hours}\right)}$$

As the USEPA term $SL_{res\text{-}soil\text{-}ca\text{-}inh}$ is the equivalent of the Department term Inh_c, the equation presented above is equivalent to the Department equation presented at N.J.A.C. 7:26D Appendix 3 as Equation 1 and verifies its equivalence with equations used by the USEPA.

N.J.A.C. 7:26D Appendix 3, Equation 1 is:

$$Inh_c = \frac{TR * AT * LT}{IUR * 1000\,{}^{\mu g}/_{mg} * EF * \left(\frac{1}{VF} + \frac{1}{PEF}\right) * ED * ET * \frac{1day}{24hours}}$$

N.J.A.C. 7:26D Appendix 3, Equation 2 – Noncarcinogenic Inhalation Human Health-Based Criteria

The Department addresses both residential and nonresidential land uses in calculating the noncarcinogenic-based inhalation exposure pathway soil criteria by applying the appropriate exposure assumptions. The equivalency demonstration made here uses the residential land use scenario equation and terminology as the specific example. The same equivalency logic also applies to the nonresidential land use scenario.

The origin of the Department residential soil remediation standard for the inhalation exposure pathway for a noncarcinogen is based upon the USEPA, Regional Screening Levels, Equations (November 2018) (RSLE):

$$SL_{res\text{-}soil\text{-}nc\text{-}tot\text{-}a}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{res\text{-}soil\text{-}nc\text{-}ing\text{-}a}} + \frac{1}{SL_{res\text{-}soil\text{-}nc\text{-}der\text{-}a}} + \frac{1}{SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}a}}}$$

This is the equation used by the USEPA to develop soil contaminant screening levels where the human health risks from the ingestion exposure pathway, the dermal exposure pathway, and the inhalation exposure pathway are combined. However, the soil remediation standards the Department developed only combine the ingestion and dermal exposure pathways and address the inhalation exposure pathway separately. Consequently, the Department modified the USEPA equation listed above by isolating the inhalation related screening level term:

$$\frac{1}{SL_{res-soil-nc-inh-a}}$$

The resulting modified equation represents not the total of the ingestion, dermal, and inhalation exposure components, but just the inhalation aspect, which is designated:

$$SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}a} = \frac{1}{\left(\frac{1}{SL_{res-soil-nc-inh-a}}\right)} = SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}a}$$

The RSLE states that:

$$SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}a}\left(mg/kg\right) = \frac{THQ \times AT_{res\text{-}a}\left(\frac{365\ days}{year} \times ED_{res}\left(26\ years\right)\right)}{EF_{res\text{-}a}\left(\frac{350\ days}{year}\right) \times ED_{res}\left(26\ years\right) \times ET_{res\text{-}a}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)} \times \left(\frac{1}{VF_{ulim}\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right)}$$

The above equation includes the units for the listed input parameters. Deleting the units simplifies the equation to:

$$SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}a} = \frac{THQ \text{ x } AT_{res-a} \text{ x } ED_{res}}{EF_{res-a} \text{ x } ED_{res} \text{ x } ET_{res-a} \text{ x } \frac{1 \text{ day}}{24 \text{ hours}} \text{ x } \frac{1}{RfC} \text{ x } \left(\frac{1}{VF_{ulim}} + \frac{1}{PEF}\right)}$$

This USEPA terminology, which is for a residential land use scenario involving a noncarcinogenic contaminant, converts to the Department terminology as follows:

USEPA Term	Department Term	USEPA Definition
THQ	***THQ***	**Target hazard quotient**
$AT_{res\text{-}a}$	***AT***	**Averaging time – residential adult**
$EF_{res\text{-}a}$	***EF***	**Exposure frequency – residential adult**
$ED_{res\text{-}a}$	***ED***	**Exposure duration – residential adult**
$ET_{res\text{-}a}$	***ET***	**Exposure time - residential adult**
RfC	***RfC***	**Reference concentration**
VF_{ulim}	***VF***	**Soil-to-air volatilization factor**
PEF	***PEF***	**Particulate emission factor**
$\frac{1 \text{ day}}{24 \text{ hours}}$	$\frac{1 \, day}{24 \, hours}$	**Unit conversion factor**

Using the above terminology to translate this equation into Departmental nomenclature, the equation becomes:

$$SL_{res\text{-}soil\text{-}nc\text{-}inh\text{-}a} = \frac{THQ \ x \ AT \ x \ ED}{EF \ x \ ED \ x \ ET \ x \ \frac{1 \ day}{24 \ hours} \ x \ \frac{1}{RfC} \ x \ \left(\frac{1}{VF} + \frac{1}{PEF}\right)}$$

As the USEPA term $SL_{res\text{-}soil\text{-}nc\text{-}inh}$ is the equivalent of the Department term Inh_{nc}, the equation presented above is equivalent to the Department equation presented in N.J.A.C. 7:26D Appendix 3 as Equation 2 and verifies its equivalence with equations used by the USEPA.

N.J.A.C. 7:26D Appendix 3, Equation 2 is:

$$Inh_{nc} = \frac{THQ * AT * ED}{EF * ED * ET * \frac{1day}{24hours} * \frac{1}{RfC} * \left(\frac{1}{VF} + \frac{1}{PEF}\right)}$$

<u>N.J.A.C. 7:26D Appendix 5, Equation 1 – Carcinogenic Indoor Air Human Health-Based Criteria</u>

The Department addresses both residential and nonresidential land uses in calculating the carcinogenic indoor air human health-based criteria by applying the appropriate exposure assumptions. The equivalency demonstration made here uses the residential land use

scenario equation and terminology as the specific example. The same equivalency logic also applies to the nonresidential land use scenario.

The origin of the Department residential indoor air remediation standard for the vapor intrusion exposure pathway for a carcinogen is based upon the USEPA, Regional Screening Levels, Equations (November 2018) (RSLE):

$$SL_{res\text{-}air\text{-}ca}\left(\mu g/m^3\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{EF_{res}\left(\frac{350\ days}{year}\right) \times ED_{res}\left(26\ years\right) \times ET_{res}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times IUR\left(\mu g/m^3\right)^{-1}}$$

The above equation includes the units for the listed input parameters. Deleting the units simplifies the equation to:

$$SL_{res\text{-}air\text{-}ca} = \frac{TR\ x\ AT_{res}\ x\ LT}{EF_{res}\ x\ ED_{res}\ x\ ET_{res}\ x\ \left(\frac{1\ day}{24\ hours}\right)\ x\ IUR}$$

This USEPA terminology, which is for a residential land use scenario involving a carcinogenic contaminant, converts to the Department terminology as follows:

USEPA Term	**Department Term**	**USEPA Definition**
TR	***TR***	**Target cancer risk**
AT_{res}	***AT***	**Averaging time - residential**

LT	***LT***	**Lifetime**
IUR	***IUR***	**Inhalation unit risk factor**
EF_{res}	***EF***	**Exposure frequency - residential**
EDres	***ED***	**Exposure duration - residential**
ETres	***ET***	**Exposure time - residential**
$\frac{\mathbf{1\ day}}{\mathbf{24\ hours}}$	$\frac{\boldsymbol{1\ day}}{\boldsymbol{24\ hours}}$	**Unit conversion factor**

Using the above terminology to translate this equation into Departmental nomenclature, the equation becomes:

$$SL_{res\text{-}air\text{-}ca} = \frac{TR\ x\ AT\ x\ LT}{EF\ x\ ED\ x\ ET\ x\ \left(\frac{1\ day}{24\ hours}\right)\ x\ IUR}$$

As the USEPA term $SL_{res\text{-}air\text{-}ca}$ is the equivalent of the Department term IA_c , the equation presented above is equivalent to the Department equation presented at N.J.A.C. 7:26D Appendix 5 as Equation 1 and verifies its equivalence with equations used by the USEPA.

N.J.A.C. 7:26D Appendix 5, Equation 1 is:

$$IA_c = \frac{TR * AT * LT}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * IUR}$$

N.J.A.C. 7:26D Appendix 5, Equation 2 – Noncarcinogenic Indoor Air Human Health-Based Criteria

The Department addresses both residential and nonresidential land uses in calculating the noncarcinogenic indoor air human health-based criteria by applying the appropriate exposure assumptions. The equivalency demonstration made here uses the residential land use scenario equation and terminology as the specific example. The same equivalency logic also applies to the nonresidential land use scenario.

The origin of the Department residential indoor air remediation standard for the vapor intrusion exposure pathway for a noncarcinogen is based upon the USEPA, Regional Screening Levels, Equations (November 2018) (RSLE):

$$SL_{res\text{-}air\text{-}nc}\left(\mu g/m^3\right) = \frac{THQ \times AT_{res\text{-}a}\left(\frac{365\ days}{year} \times ED_{res}\left(26\ years\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{res}\left(\frac{350\ days}{year}\right) \times ED_{res}\left(26\ years\right) \times ET_{res}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)}}$$

The above equation includes the units for the listed input parameters. Deleting these units simplifies the equation to:

$$SL_{res\text{-}air\text{-}nc} = \frac{THQ \text{ x } AT_{res-a} \text{ x } ED_{res} \text{ x } \left(\frac{1000\ ug}{mg}\right)}{EF_{res} \text{ x } ED_{res} \text{ x } ET_{res} \text{ x } \left(\frac{1\ day}{24\ hours}\right) \text{ x } \left(\frac{1}{RfC}\right)}$$

This USEPA terminology, which is for a residential land use scenario involving a noncarcinogenic contaminant, converts to the Department terminology as follows:

USEPA Term	Department Term	USEPA Definition
THQ	***THQ***	**Target hazard quotient**
$AT_{res\text{-}a}$	***AT***	**Averaging time – residential adult**
EF_{res}	***EF***	**Exposure frequency – residential adult**
ED_{res}	***ED***	**Exposure duration – residential adult**
ET_{res}	***ET***	**Exposure time - residential adult**
RfC	***RfC***	**Reference concentration**
$\frac{1000\ ug}{mg}$	$\frac{1000\ ug}{mg}$	**Unit conversion factor**
$\frac{1\ day}{24\ hours}$	$\frac{1\ day}{24\ hours}$	**Unit conversion factor**

Using the above terminology to translate this equation into Departmental nomenclature, the equation becomes:

$$SL_{res\text{-}air\text{-}nc} = \frac{THQ \ x \ AT \ x \ ED \ x \left(\frac{1000\,ug}{mg}\right)}{EF \ x \ ED \ x \ ET \ x \left(\frac{1\,day}{24\,hours}\right) \ x \left(\frac{1}{RfC}\right)}$$

As the USEPA term $SL_{res\text{-}air\text{-}nc}$ is the equivalent of the Department term IA_{nc}, the equation presented above is equivalent to the equation presented at N.J.A.C. 7:26D Appendix 5 as Equation 2 and verifies its equivalence with equations used by the USEPA.

N.J.A.C. 7:26D Appendix 5, Equation 2 is:

$$IA_{nc} = \frac{THQ * AT * ED * \frac{1000\,\mu g}{mg}}{EF * ED * ET * \frac{1}{24}\frac{day}{hours} * \frac{1}{RfC}}$$

References

USEPA (2018) Regional Screening Levels (RSLs) – Equations (November 2018)

https://www.epa.gov/risk/regional-screening-levels-rsls-equations

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SUBCHAPTER 1. GENERAL INFORMATION

7:26E-1.5 General remediation requirements

(a) – (b) (No change.)

(c) The person responsible for conducting the remediation of a site shall remediate[:

1. To] **to** comply with the Remediation Standards, N.J.A.C. 7:26D[; or]**.**

[2. To comply with the standards or criteria developed by the Department under N.J.S.A. 58:10B-12a for that site prior to June 2, 2008, provided:

i. A remedial action workplan or a remedial action report containing standards or criteria developed for the site under N.J.S.A. 58:10B-12a was submitted to the Department before December 2, 2008;

ii. The remedial action workplan or a remedial action report meets the requirements of N.J.A.C. 7:26E-5.5 or N.J.A.C. 7:26E-5.7, respectively, and is approved as written by a licensed site remediation professional; and

iii. The standards or criteria developed by the Department under N.J.S.A. 58:10B-12a for the site are not greater by an order of magnitude, than the remediation standards otherwise applicable under N.J.A.C. 7:26D.]

(d) – (i) (No change.)