



**New Jersey Department of Environmental Protection**



**Site Remediation Program**

## **Technical Guidance for the Attainment of Remediation Standards and Site-Specific Criteria**

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## **1.0 Intended use of guidance document**

This guidance is designed to help the person responsible for conducting the remediation to comply with the New Jersey Department of Environmental Protection (Department) requirements established by the Technical Requirements for Site Remediation (Technical Requirements), N.J.A.C. 7:26E. This guidance will be used by many different people involved in the remediation of a contaminated site; such as Licensed Site Remediation Professionals (LSRP), Non-LSRP environmental consultants and other environmental professionals. Therefore, the generic term “investigator” will be used to refer to any person who uses this guidance to remediate a contaminated site on behalf of a remediating party, including the remediating party itself.

The procedures for a person to vary from the technical requirements in regulation are outlined in the Technical Requirements at N.J.A.C. 7:26E-1.7. Variances from a technical requirement or departure from guidance must be documented and adequately supported with data or other information. In applying technical guidance, the Department recognizes that professional judgment may result in a range of interpretations on the application of the guidance to site conditions.

This guidance supersedes previous Department guidance issued on this topic.

This guidance was prepared with stakeholder input. The following people were on the committee who prepared this document:

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## **2.0 Purpose**

This guidance presents recommended procedures for achieving compliance with applicable remediation standards, alternative remediation standards, and/or site-specific criteria pursuant to the Department’s Remediation Standards, N.J.A.C. 7:26D, and in accordance with the Technical Requirements for Site Remediation, N.J.A.C. 7:26E. The investigator should follow this guidance to determine if remediation is necessary and to demonstrate if remediation satisfies regulatory requirements including the Department’s Remediation Standards.

This guidance applies to the Site Investigation (SI), Remedial Investigation (RI) and Remedial Action (RA) phases of the remedial process. Specific recommended procedures are provided for applying this guidance to soil, ground water, sediment, and surface water in each of these phases to assess remedial requirements, i.e., to demonstrate that remediation standards have been achieved. In addition to the procedures presented in this guidance, the investigator is also referred to additional media-specific and pathway-specific technical guidance for detailed methodologies (e.g., vapor intrusion, light non-aqueous phase liquids (LNAPL), soil site investigation/remedial investigation (SI/RI), ground water SI/RI, etc.). These technical guidances are available for viewing and downloading on the Department website at [www.nj.gov/dep/srp/guidance/index.html](http://www.nj.gov/dep/srp/guidance/index.html).

### **3.0 Document overview**

This technical guidance provides the investigator with several options to achieve compliance with the applicable remediation standards throughout the remediation process (i.e., site investigation, remedial investigation, remedy selection, remedial action), including ‘point by point’ compliance at individual sampling points, relatively simple statistical tests to allow for identification and elimination of data outliers, and more robust numerical and spatial statistical methods. In order to determine which option would be used to demonstrate compliance with the Department’s Remediation Standards, the investigator should evaluate the data available and apply professional judgment.

The use of this guidance does not replace the need for documenting procedures and/or methodologies for proper remediation in accordance with Department regulatory requirements. The demonstration of attainment of the Department’s Remediation Standards must be documented in the appropriate remediation document(s) and submittal(s) pursuant to the Technical Requirements and the Administrative Requirements for the Remediation of Contaminated Sites (ARRCS) N.J.A.C. 7:26C.

Detailed procedures for demonstrating attainment with the Department’s Remediation Standards are presented in the following sections of the guidance:

Section 5.0 - General Concepts: This section presents the technical approach for applying Remediation Standards during the site investigation, remedial investigation and remedial action phases.

Section 6.0 - Soil: This section identifies each of the exposure pathways for soil impacts including the Direct Contact Ingestion – Dermal and Inhalation Exposure Pathways and Impact to Ground Water Exposure Pathway. In addition, this section references the methodologies for developing alternative remediation standards for each exposure pathway. This section also discusses Ecological Soil and Sediment Exposure Pathways, as well as alternatives for demonstrating attainment of the Soil Remediation Standards during the Site Investigation, Remedial Investigation and Remedial Action Phases. This includes procedures for determining the need for remedial action for each of the soil exposure pathways.

Section 7.0 - Ground Water: This section reviews applicable Remediation Standards and Vapor Screening Levels for ground water and alternatives for demonstrating attainment of the Standards during the Site Investigation, Remedial Investigation and Remedial Action Phases. This includes procedures for determining the need for remedial action for each of the ground water exposure pathways.

Section 8.0 - Surface Water: This section reviews applicable Remediation Standards for surface water and alternatives for demonstrating attainment of the Standards during the Site Investigation, Remedial Investigation and Remedial Action Phases. This includes procedures for determining the need for remedial action.

#### **4.0 Introduction**

The Department adopted the Remediation Standards (N.J.A.C. 7:26D) in June 2008 for use at remediation sites. The Remediation Standards set forth numeric and narrative standards for soils, ground water, and surface water. Prior to adoption of the Remediation Standards, the Department had used “soil cleanup criteria” (SCC), Ground Water Quality Standards (N.J.A.C. 7:9C), and Surface Water Quality Standards (N.J.A.C. 7:9B) as site specific numeric remediation standards. Adoption of the Remediation Standards served to administratively document the process that the Department has been implementing for many years.

The purpose of this guidance document is two-fold: to assist the investigator with identifying and applying appropriate remediation standards, criteria and conditions for detected contaminants in all media during each phase of a remediation (site investigation, remedial investigation, and remedial action); and, to determine compliance with these remediation standards, criteria and conditions to ensure protection of human health and of the environment.

When determining appropriate remediation standards and criteria, it is critical that the investigator have an understanding of the intended use of the site once remediation is complete (“end use”). Questions to be considered include whether the site will be used for residential or non-residential purposes, and whether the use of institutional and/or engineering controls is acceptable at the site. While compliance has traditionally been based on single-point determinations (see definition in Appendix B), the number of points required to demonstrate that the remediation is protective of human health and of the environment, and the manner in which the data are evaluated, may vary depending on the remedial phase and the intended end use of the property. It should be noted that this document will not set forth guidelines for determining the technical aspects of the sampling investigation (i.e., appropriate sampling strategies, number of samples to be collected, etc.). The investigator is referred to the Technical Requirements, as well as the applicable guidance documents prepared by the Department that address these issues.

The investigator is encouraged to develop a conceptual site model (CSM) following Department guidance to develop and provide a framework that can be used to aid and document site characterization and remedial action decisions throughout the life of the remediation. The CSM is a written and/or illustrative representation of the physical, chemical and biological processes that control the transport, migration and potential impacts to receptors. Development and

refinement of the CSM will help identify data gaps in the characterization process and can ultimately support remedial decision making. The Department accepts the CSM as a valid scientific approach when applied in accordance with applicable regulatory requirements and guidance documents.

This Department technical guidance document will provide direction on how to apply:

- Direct contact soil remediation standards, ground water remediation standards, and surface water remediation standards pursuant to the Remediation Standards (N.J.A.C. 7:26D; [www.nj.gov/dep/srp/regs/rs/](http://www.nj.gov/dep/srp/regs/rs/)).
- Impact to ground water soil remediation standards pursuant to the guidance documents at [www.nj.gov/dep/srp/guidance/rs](http://www.nj.gov/dep/srp/guidance/rs).

Media include soil, ground water, surface water, sediment, and air. Soil exposure pathways include ingestion-dermal, inhalation, impact to ground water, and aquatic. Ground water exposure pathways include both drinking water and vapor intrusion. As defined in the “Vapor Intrusion Technical Guidance” ([www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm](http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm)) vapor intrusion is the migration of volatile chemicals from the subsurface into overlying buildings. Surface water exposure pathways include both human health and aquatic.

It should be noted that this document does not address compliance for the following:

- Petroleum hydrocarbons. Compliance issues regarding petroleum hydrocarbons can be found in the Department “Protocol for Addressing Extractable Petroleum Hydrocarbons” guidance document ([www.nj.gov/dep/srp/guidance/srra/eph\\_protocol.pdf](http://www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf)).
- Ecological. Compliance issues regarding ecological issues, with the exception of certain surface water standards, are to be found in the Department “Ecological Evaluation Technical Guidance” ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)).
- Vapor intrusion. Compliance issues regarding vapor intrusion are found in the Department “Vapor Intrusion Technical Guidance” ([www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm](http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm)).

Table 4-1 on the following page provides details on the above information.



Table 4-1: Summary of Media, Pathways, Standards/Criteria

MEDIA	PATHWAY(S)	STANDARDS/CRITERIA	CITATION
Soil	Direct Contact (ingestion-dermal, inhalation)	Direct Contact Residential and Non-residential Soil Remediation Standards	N.J.A.C. 7:26D-4
		Extractable Petroleum Hydrocarbons	<a href="http://www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf">www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf</a>
	Impact to Ground Water	Site-Specific Impact to Ground Water Soil Remediation Standards	N.J.A.C. 7:26D-1.1(b)
Ground Water	Ground Water	Ground Water Remediation Standards	N.J.A.C. 7:26D-2 (N.J.A.C. 7:9C)*
Surface Water	Human Health	Human Health Surface Water Quality Standards	N.J.A.C. 7:26D-3 (N.J.A.C. 7:9B)#
	Ecological	Aquatic Surface Water Quality Standards	N.J.A.C. 7:9B
Sediment	Human Health (Direct Contact Soil)	See Soil	N.J.A.C. 7:26D-4
	Ecological	Ecological Evaluation Technical Guidance	<a href="http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf">www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf</a>
		Extractable Petroleum Hydrocarbons	<a href="http://www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf">www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf</a>
“Vapor Intrusion”	Ground Water, Soil Gas, Indoor Air	Vapor Intrusion Technical Guidance	<a href="http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm">www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm</a>

\* The Ground Water Remediation Standards reference the Ground Water Quality Standards, N.J.A.C. 7:9C.

# The Surface Water Remediation Standards reference the Surface Water Quality Standards, N.J.A.C. 7:9B.

Pursuant to the Technical Requirements, the person responsible for conducting the remediation is required to determine appropriate remediation standards, site-specific alternative remediation standards (if desired), and/or site-specific criteria for each contaminant detected at the site or area of concern (AOC) for all media and exposure pathways (as appropriate). For the purposes of this guidance document, the phrase “applicable remediation standard” is to be applied to the remediation standard, alternative remediation standard, and/or site-specific criterion.

The applicable remediation standard for a given contaminant depends upon the intended future use of the site (e.g., residential or non-residential), as well as potential exposure pathways that are being remediated (e.g., ground water, surface water, impact to ground water). In general, attainment of compliance refers to the process by which analytical data from a site or AOC are compared against all applicable remediation standards, and a determination made as to whether existing site conditions meet or exceed those standards. Based on this determination, a decision is then made regarding the need for additional remediation at the site or AOC, including but not limited to additional delineation sampling and/or remedial actions. Compliance determinations should be performed at the conclusion of each phase of a remediation (site investigation, remedial investigation and remedial action).

Specific to remedial actions, pursuant to N.J.S.A. 58:10B-12g(4), the person responsible for conducting the remediation is not required to remediate contamination to below background concentrations. Refer to the Technical Requirements for regulatory obligations regarding background investigations (N.J.A.C. 7:26E-3.8 and 3.9).

## **5.0 General concepts**

### **5.1 Site investigation**

Pursuant to N.J.A.C. 7:26E-3.3(a), the purpose of the site investigation is to “determine if additional remediation is necessary because contaminants are present at the site or area of concern, or because contaminants have emanated or are emanating from the site or area of concern, above any applicable remediation standard or criterion.”

In general, single point compliance is employed during the site investigation, using the most conservative applicable remediation standard. The Technical Requirements allow the person responsible for conducting the remediation to either conduct a remedial investigation or to immediately commence with a remedial action. This decision is made by the person responsible for conducting the remediation, based on the appropriate Department guidance, and is not discussed in this document.

### **5.2 Remedial investigation**

Pursuant to N.J.A.C. 7:26E-4.1(a)1, the purpose of the remedial investigation is to “Delineate the horizontal and vertical extent of contamination to the remediation standard, in each environmental medium at a contaminated site ...”

The goal of the remedial investigation should be to achieve delineation and characterization of the nature and extent of contamination as appropriate to determine the necessity for and the proposed extent of a remedial action, in order to support the development and evaluation of proposed alternatives in the remedy selection process.

As with the site investigation, in general, single point compliance is employed during the remedial investigation, using the most conservative applicable remediation standard. Put simply,

if contamination is determined to be present at the site during the remedial investigation above the applicable remediation standard, the person responsible for conducting the remediation is required to determine whether it is necessary to conduct a remedial action. Alternatives to demonstrate that compliance is achieved for each specified pathway using compliance averaging procedures are detailed in Section 6 (soil) and Section 7 (ground water).

### **5.3 Remedial action**

If through the site investigation and/or remedial investigation it is determined that contamination is present at a site or AOC at concentrations not in compliance with the applicable remediation standard, a remedial action is required. Requirements pertaining to the type of remedial action are contained in the Department guidance “Ground Water Technical Guidance: Site Investigation/Remedial Investigation/Remedial Action Performance Monitoring” ([www.nj.gov/dep/srp/guidance/srra/gw\\_inv\\_si\\_ri\\_ra.pdf](http://www.nj.gov/dep/srp/guidance/srra/gw_inv_si_ri_ra.pdf)) and “Soil Investigation Technical Guidance - Site Investigation/Remedial Investigation/Remedial Action (SI/RI/RA)” ([www.nj.gov/dep/srp/guidance/srra/soil\\_inv\\_si\\_ri\\_ra.pdf](http://www.nj.gov/dep/srp/guidance/srra/soil_inv_si_ri_ra.pdf)).

After completion of the remedial action if contaminants are still present above the applicable remediation standard, compliance averaging as specified in Sections 6 and 7 may be used (for each pathway) to determine if the site or AOC is in compliance or if additional remedial action is warranted.

## **6.0 Soil**

This section presents the process for determining the applicable remediation standard, and is organized as follows:

- 6.1 - Direct contact soil exposure pathways soil remediation standards
- 6.2 - Impact to ground water soil exposure pathway soil remediation standards
- 6.3 - Site-specific standards for contaminants not in the table
- 6.4 - Ecological soil and sediment screening levels
- 6.5 - Petroleum hydrocarbon soil screening levels
- 6.6 - Vapor intrusion soil screening levels

The final subsection (6.7) discusses how to demonstrate attainment of compliance with those standards and screening levels, again by pathway.

### **6.1 Direct Contact Exposure Pathways Soil Remediation Standards**

Applicable numerical remediation standards for the two direct contact exposure pathways include:

- Those promulgated in Table 1A and Table 1B of Appendix 1 in the Remediation Standards (N.J.A.C. 7:26D), or criteria developed for human-health receptors through other guidance documents; or

- Alternative remediation standards developed pursuant to the Remediation Standards (N.J.A.C. 7:26D-7, and either Appendix 4 [ingestion-dermal exposure pathway] or Appendix 5 [inhalation exposure pathway]).

### **6.1.1 Direct Contact Remediation Standards or Criteria**

Direct Contact Pathways include both the Ingestion-Dermal Exposure Pathway as well as the Inhalation Pathway. In addition, for each of these pathways, there are both residential and non-residential soil remediation standards.

For each contaminant detected in soil at the site or AOC, the investigator needs to select both the residential and non-residential direct contact soil remediation standards using the Remediation Standards, specifically, N.J.A.C. 7:26D-4 and Appendix 1. Numerical residential direct contact soil remediation standards are to be selected from the column “Residential Direct Contact Soil Remediation Standard” in Table 1A (for residential remediation standards), and numerical non-residential direct contact soil remediation standards are to be selected from the column “Non-Residential Direct Contact Soil Remediation Standard” in Table 1B. Additional criteria for other contaminants that have been developed for human-health receptors are found in guidance documents for those contaminants (e.g., extractable petroleum hydrocarbons, chromium).

### **6.1.2 Alternative Remediation Standards**

In lieu of selecting the remediation standard from Table 1A or Table 1B, if sufficient information is available, then the investigator may choose to develop a site-specific alternative remediation standard for each contaminant detected at the site or AOC pursuant to N.J.A.C. 7:26D-7, as follows. Use the Department guidance documents provided at [www.nj.gov/dep/srp/guidance/rs/](http://www.nj.gov/dep/srp/guidance/rs/) in effect as of the date the report is submitted.

Pursuant to N.J.A.C. 7:26D-7.4(a), the investigator is required to complete and submit the form “Alternative soil remediation standard and/or screening level application form” available at [www.nj.gov/dep/srp/srra/forms/](http://www.nj.gov/dep/srp/srra/forms/).

#### **6.1.2.1 Ingestion-dermal exposure pathway**

Use N.J.A.C. 7:26D Appendix 4 (“Methods for the Development of Alternative Ingestion-Dermal Soil Remediation Standards”). Note that pursuant to N.J.A.C. 7:26D-7.4, any alternative soil remediation standard developed for the ingestion-dermal exposure pathway requires Department approval prior to their use at a site or AOC.

#### **6.1.2.2 Inhalation exposure pathway**

Use N.J.A.C. 7:26D Appendix 5 (“Methods for the Development of Alternative Inhalation Soil Remediation Standards”) and the Department “Guidance Document - Inhalation Standards Compliance - Development of Alternative Remediation Standards for the Inhalation Pathway” ([www.nj.gov/dep/srp/guidance/rs/compl\\_ars\\_inhalation.pdf](http://www.nj.gov/dep/srp/guidance/rs/compl_ars_inhalation.pdf)).

Note that pursuant to N.J.A.C. 7:26D-7.5, alternative remediation standards developed based on site-specific conditions that support modification of input parameters for the models used to develop alternative remediation standards pursuant to N.J.A.C. 7:26D Appendix 5 do not require Department approval prior to their use at a site or AOC unless the alternative remediation standard was developed based on the following options which do require Department approval prior to their use at a site or AOC:

New toxicity information, pursuant to N.J.A.C. 7:26D-7.3(b)1; or

New or alternative modeling, pursuant to N.J.A.C. 7:26D-7.3(b)2.

## **6.2 Impact to Ground Water Exposure Pathway Soil Remediation Standards**

For each contaminant detected in soil at the site or AOC, the investigator is required to develop site-specific impact to ground water exposure pathway soil remediation standards pursuant to N.J.A.C. 7:26D-1.1(b), and following the Department guidance “Introduction to Site-Specific Impact to Ground Water Soil Remediation Standards Guidance Documents” ([www.nj.gov/dep/srp/guidance/rs/igw\\_intro.htm](http://www.nj.gov/dep/srp/guidance/rs/igw_intro.htm)). The site-specific impact to ground water exposure pathway soil remediation standard is to be based upon the classification of the ground water located at the site or AOC:

- Class I (exceptional ecological areas; Pinelands)
- Class II (potable)
- Class III (aquifers, salt water intrusion)

For Class I and Class III ground water, the investigator is required to develop site-specific impact to ground water exposure pathway soil remediation standards for a contaminant. It should be noted that pursuant to N.J.A.C. 7:9C-1.10, classifying ground water as either Class I or Class III requires Department approval; for ground water reclassified as Class III, the Department also needs to approve any proposed ground water quality standards.

If more than one of the methods listed below is used to develop a site-specific impact to ground water exposure pathway soil remediation standard for a given contaminant, then the greatest value calculated should be used as the site-specific impact to ground water exposure pathway soil remediation standard. For additional information, see the list of guidance documents and web links listed in sections 6.2 through 6.6 below, as well as the frequently asked questions ([www.nj.gov/dep/srp/guidance/rs/igw\\_faq.pdf](http://www.nj.gov/dep/srp/guidance/rs/igw_faq.pdf)).

### **6.2.1 Department pre-approval not required**

Development of site-specific impact to ground water exposure pathway soil remediation standards using the following guidance documents (in effect as of the date the site-specific impact to ground water exposure pathway soil remediation standard is calculated) does not require Department approval prior to their use and implementation:

- “Guidance for the Use of the Synthetic Precipitation Leaching Procedure to Develop Site-Specific Impact to Ground Water Remediation Standards” ([www.nj.gov/dep/srp/guidance/rs/splp\\_guidance.pdf](http://www.nj.gov/dep/srp/guidance/rs/splp_guidance.pdf)).
- “Guidance Document - Development of Site-Specific Impact to Ground Water Soil Remediation Standards Using the Soil-Water Partition Equation” ([www.nj.gov/dep/srp/guidance/rs/partition\\_equation.pdf](http://www.nj.gov/dep/srp/guidance/rs/partition_equation.pdf)).
- “Guidance for the Determination of the Dilution-Attenuation Factor for the Impact to Ground Water Pathway” ([www.nj.gov/dep/srp/guidance/rs/daf.pdf](http://www.nj.gov/dep/srp/guidance/rs/daf.pdf)).

### **6.2.2 Department pre-approval required**

Due to the complexities involved, development of site-specific impact to ground water exposure pathway soil remediation standards using the following guidance documents require Department approval prior to their use and implementation:

- “Guidance Document - Using the SESOIL Transport Model to Assess the Impact to Ground Water Pathway” (vadose zone modeling) ([www.nj.gov/dep/srp/guidance/rs/sesoil.pdf](http://www.nj.gov/dep/srp/guidance/rs/sesoil.pdf)).
- “Guidance for Using the SESOIL and AT123D Models to Develop Site Specific Impact to Ground Water Soil Remediation Standards” (vadose zone/saturated zone modeling) ([www.nj.gov/dep/srp/guidance/rs/at123d\\_guidance.pdf](http://www.nj.gov/dep/srp/guidance/rs/at123d_guidance.pdf)).

### **6.3 Site-specific standards for contaminants not in the table**

For contaminants that are not included in any of the above tables, see the Remediation Standards, N.J.A.C. 7:26D-5, for the process for developing interim soil remediation standards.

### **6.4 Ecological Soil and Sediment Screening Levels**

Ecological soil and sediment screening levels are discussed in the Department “Ecological Evaluation Technical Guidance” ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)). Additionally, the ecological screening level for petroleum hydrocarbons is discussed in the Department “Protocol for Addressing Extractable Petroleum Hydrocarbons” guidance document ([www.nj.gov/dep/srp/guidance/srra/eph\\_protocol.pdf](http://www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf)).

### **6.5 Petroleum Hydrocarbon Soil Screening Levels**

Petroleum hydrocarbon criteria and screening levels are discussed in the Department “Protocol for Addressing Extractable Petroleum Hydrocarbons” guidance document ([www.nj.gov/dep/srp/guidance/srra/eph\\_protocol.pdf](http://www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf)).

## **6.6 Vapor Intrusion Soil Screening Levels**

There are no soil-based standards, criteria, or screening levels for the vapor intrusion pathway. See sections 2.1 and 3.1.2.4 of the Department Vapor Intrusion Technical Guidance for further discussion of this issue ([www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm](http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm)).

## **6.7 Compliance**

### **6.7.1 General**

Compliance with the applicable soil remediation standards typically will involve comparison of contaminant concentrations to the most conservative (i.e., lowest) soil remediation standard. In most cases, this will be either the residential direct contact soil remediation standard or the impact to ground water soil remediation standard.

There are five (5) contaminants for which the non-residential inhalation exposure pathway soil remediation standard is the most conservative direct contact soil remediation standard: acenaphthylene, benzo(ghi)perylene, cobalt, manganese, and phenanthrene. For additional discussion, see the document “Inhalation Exposure Pathway Soil Remediation Standards Basis and Background June 2008” ([www.nj.gov/dep/srp/regs/rs/bb\\_inhalation.pdf](http://www.nj.gov/dep/srp/regs/rs/bb_inhalation.pdf)). For these five (5) contaminants only, the compliance comparison will be made to the lower of either the non-residential direct contact soil remediation standard or the impact to ground water soil remediation standard.

### **6.7.2 Site investigation**

During the site investigation, compliance for all contaminants for all exposure pathways for all soil remediation standards will be based on single-point compliance.

With the five (5) exceptions noted in 6.7.1 above, the single-point compliance comparison will be made to the lower of either the residential direct contact soil remediation standard or the impact to ground water soil remediation standard.

If any contaminant concentration level in any sample exceeds the lower of either the residential direct contact soil remediation standard or the impact to ground water soil remediation standard, then the person responsible for conducting the remediation is required to conduct a remedial investigation for the site or AOC pursuant to N.J.A.C. 7:26E-4. Alternatively, pursuant to N.J.A.C. 7:26E-4.2(c), the person responsible for conducting the remediation can proceed directly to the remedial action (N.J.A.C. 7:26E-5).

Additional actions may be required relative to ecological issues; refer to the Department “Ecological Evaluation Technical Guidance” ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)).

### **6.7.3 Remedial investigation - delineation**

As previously presented in Section 5.2, there are two separate determinations regarding compliance with the applicable soil remediation standards as part of the remedial investigation. This subsection (6.7.3) describes the process of determining whether both horizontal and vertical delineation are complete, as appropriate. The following subsection (6.7.4) describes the process of determining whether and what type of a remedial action is required. To determine whether delineation is complete, single-point compliance is to be used.

#### **6.7.3.1 Delineation - direct contact exposure pathways**

For direct contact exposure pathways, horizontal and vertical delineation compliance is dependent upon the type of remedial action selected (i.e., current and/or future end use) for the site or AOC, as well as whether the applicable direct contact soil remediation standard is determined by the ingestion-dermal exposure pathway or the inhalation exposure pathway. It should also be noted that for direct contact exposure pathways, delineation is to continue until the applicable soil remediation standard is achieved, regardless of whether ground water is encountered or not. Delineation does not stop at the water table.

Regardless of the type of remedial action presumed for the site, the investigator must:

- Demonstrate delineation compliance with the impact to ground water exposure pathway soil remediation standards, as applicable (i.e., only apply in the unsaturated zone; see section 6.7.3.2 below) pursuant to the Technical Requirements (N.J.A.C. 7:26E-4 [[www.nj.gov/dep/rules/rules/njac7\\_26e.pdf](http://www.nj.gov/dep/rules/rules/njac7_26e.pdf)]).
- Delineate for the presence of free and/or residual product pursuant to the Technical Requirements (N.J.A.C. 7:26E-2.1(a)14, N.J.A.C. 7:26E-4.2(a)4, and N.J.A.C. 7:26E-4.3(a)3). Free and/or residual product is to be remediated pursuant to the Technical Requirements (N.J.A.C. 7:26E-5.1(e)) and the Department “Light Non-aqueous Phase Liquid (LNAPL) Initial Recovery and Interim Remedial Measures Technical Guidance” ([www.nj.gov/dep/srp/guidance/srra/lnapl\\_guidance.pdf](http://www.nj.gov/dep/srp/guidance/srra/lnapl_guidance.pdf)).
- If applicable, evaluate for the presence of sheen pursuant to the Department policy ([www.nj.gov/dep/srp/guidance/sheen/](http://www.nj.gov/dep/srp/guidance/sheen/)) in effect as of the date the evaluation is performed in the field. If sheen is present that needs to be addressed pursuant to the sheen policy, then the necessary corrective actions are to be taken pursuant to the Department policy in effect as of the date the report is submitted.

##### **6.7.3.1.1 Unrestricted use remedial action**

For sites or AOC for which an unrestricted use remedial action is selected, horizontal and vertical delineation is to proceed to the residential direct contact soil remediation standard.

Horizontal and vertical delineation for direct contact purposes is considered complete for unrestricted use scenarios when all perimeter soil contaminant concentrations are less than or



equal to the applicable residential direct contact soil remediation standard for each contaminant present.

#### **6.7.3.1.2 Limited restricted use remedial action**

For sites or AOC for which a limited restricted use remedial action is selected, horizontal and vertical delineation, as applicable, is to proceed to the non-residential direct contact soil remediation standard for the site or AOC that will be subject to the restriction. In addition, pursuant to N.J.A.C. 7:26E-4.2(a)2, the investigator shall determine whether contamination has migrated off the property, both horizontally and vertically, as appropriate, to the residential direct contact soil remediation standard.

#### **6.7.3.1.3 Restricted use remedial action**

For sites or AOC for which a restricted use remedial action is selected, horizontal and vertical delineation is to consist of the following, as applicable:

- For residential sites: to the residential direct contact soil remediation standard at the boundary of the restricted area.
- For non-residential sites: to the non-residential direct contact soil remediation standard at the boundary of the restricted area, and to the residential direct contact soil remediation standard at the property boundary.

In addition, pursuant to N.J.A.C. 7:26E-4.2(a)2, the investigator shall determine whether contamination has migrated off the property, both horizontally and vertically, as appropriate, to the residential direct contact soil remediation standard.

#### **6.7.3.2 Delineation - impact to ground water exposure pathway**

Horizontal and vertical delineation for the impact to ground water exposure pathway will be considered complete when all soil contaminant concentrations are less than or equal to the applicable impact to ground water exposure pathway soil remediation standard selected pursuant to section 6.2 above. It should also be noted that for the impact to ground water exposure pathway, delineation is only required within the vadose zone.

#### **6.7.4 Remedial investigation - determine need for remedial action**

Following completion of delineation (using single point compliance) to the applicable soil remediation standard, the investigator is to determine whether compliance with the applicable soil remediation standard has now been achieved using one of the compliance options detailed below. To determine whether a remedial action is required based upon the ingestion-dermal, inhalation, and impact to ground water exposure pathways, either single-point compliance or compliance averaging can be used. If compliance has not been achieved, then a remedial action is required.

#### 6.7.4.1 Direct contact exposure pathways

To determine whether a remedial action is required based upon the ingestion-dermal and the inhalation exposure pathways, use either single-point compliance or compliance averaging.

Any of the following compliance options can be used to determine if a remedial action is required for both the ingestion dermal and inhalation pathways:

- Single-point compliance
- Compliance averaging by calculating the arithmetic mean for the data set where there are two or fewer distinct sample values or nine or fewer total sample points
- Compliance averaging at the 95 percent upper confidence limit (UCL) of the mean
- Compliance averaging using a spatially weighted average (e.g., Thiessen polygons)

It should be noted that compliance averaging cannot be performed on the sample results derived using the incremental sampling approach (Interstate Technology and Regulatory Council, February 2012, [www.itrcweb.org/ism-1/](http://www.itrcweb.org/ism-1/)) conducted in accordance with the February 2012 Department *Soil Investigation Technical Guidance - Site Investigation/Remedial Investigation/Remedial Action (SI/RI/RA)* ([http://www.nj.gov/dep/srp/guidance/srra/soil\\_inv\\_si\\_ri\\_ra.pdf](http://www.nj.gov/dep/srp/guidance/srra/soil_inv_si_ri_ra.pdf)) (i.e., compliance for such samples is determined based on single point compliance).

See Appendix A for detailed guidance on compliance averaging using the arithmetic mean of the data set, compliance averaging at the 95 percent UCL of the mean, and compliance averaging using a spatially weighted average.

Other methods may be proposed by the investigator, where such an approach is relevant and appropriate to site conditions in the professional judgment of the investigator. Consultation with the Department is recommended if methods not discussed in this document are used.

If single-point compliance is used and the concentration of each contaminant is less than or equal to its applicable direct contact exposure pathway soil remediation standard then no remedial action is required for soils for the direct contact exposure pathways for the site or AOC. If compliance averaging is used for appropriate ingestion-dermal and/or inhalation exposure pathway contaminants and the average contaminant concentration of each contaminant is less than or equal to its applicable direct contact exposure pathway soil remediation standard, then no remedial action is required for soils for the direct contact exposure pathways for the site or AOC.

If the averaged concentration of any contaminant exceeds its applicable direct contact soil remediation standard, then the person responsible for conducting the remediation is required to select and conduct a remedial action pursuant to N.J.A.C. 7:26E-5.

If delineation indicates that contamination extends offsite at any depth, then delineation and compliance with the direct contact soil remediation standard is to be determined by applying the most restrictive direct contact soil remediation standard to the offsite contaminated area. The contaminated offsite area shall be addressed separately using either single point compliance or

compliance averaging. The contaminants in the offsite area are to be compared to the most restrictive direct contact soil remediation standard, irrespective of its current land use.

In all situations, the actual type of remedial action required will depend upon the end use of the site or AOC (i.e., residential or non-residential). This decision is to be made on a case-by-case basis, and is not discussed in this guidance document.

The investigator still must demonstrate compliance with the impact to ground water exposure pathway soil remediation standards, as applicable (see section 6.7.4.2 below).

#### **6.7.4.2 Impact to ground water exposure pathway**

To determine whether a remedial action is required based upon the impact to ground water pathway, any of the following compliance options can be used:

- Single-point compliance
- Compliance averaging by calculating the arithmetic mean for the data set where there are two or fewer distinct sample values or nine or fewer total sample points
- Compliance averaging at the 95 percent UCL of the mean
- Compliance averaging using a spatially weighted average (e.g., Thiessen polygons)

It should be noted that compliance averaging cannot be performed on the sample results derived using the incremental sampling approach (Interstate Technology and Regulatory Council, February 2012, [www.itrcweb.org/ism-1/](http://www.itrcweb.org/ism-1/)) conducted in accordance with the February 2012 Department *Soil Investigation Technical Guidance - Site Investigation/Remedial Investigation/Remedial Action (SI/RI/RA)* ([http://www.nj.gov/dep/srp/guidance/srra/soil\\_inv\\_si\\_ri\\_ra.pdf](http://www.nj.gov/dep/srp/guidance/srra/soil_inv_si_ri_ra.pdf)) (i.e., compliance for such samples is determined based on single point compliance).

See Appendix A for detailed guidance on compliance averaging using the arithmetic mean of the data set, compliance averaging at the 95 percent UCL of the mean, and compliance averaging using a spatially weighted average.

Unlike the direct contact pathways, determining compliance for the impact to ground water pathway is based on the full extent of the contamination. Onsite and offsite areas are not evaluated separately. The reason for this is because the receptor, the ground water, is not confined to a site, but extends across the adjacent site and beyond. The same compliance procedures are used whether an AOC extends offsite or not. The investigator is referred to Appendix A for additional details.

Other methods may be proposed by the investigator, where such an approach is relevant and appropriate to site conditions in the professional judgment of the investigator. Consultation with the Department is recommended if methods not discussed in this document are used.

Alternatively, the investigator can demonstrate that no further remediation is required for the impact to ground water pathway by meeting the requirements of the following guidance documents (as applicable) in effect at the time the applicable report is submitted:

- “Guidance for the Evaluation of Immobile Chemicals for the Impact to Ground Water Pathway” ([www.nj.gov/dep/srp/guidance/rs/immobile\\_chemicals.pdf](http://www.nj.gov/dep/srp/guidance/rs/immobile_chemicals.pdf)).
- “Site Soil and Ground Water Analytical Data Evaluation” (Metals and Semi-Volatile Organic Compounds Contamination) ([www.nj.gov/dep/srp/guidance/rs/observed\\_metals\\_semivocs.pdf](http://www.nj.gov/dep/srp/guidance/rs/observed_metals_semivocs.pdf)).
- “Site Soil and Ground Water Analytical Data Evaluation” (Volatile Organic Contamination including methyl tertiary butyl ether (MTBE) and tertiary butyl alcohol (TBA) derived from discharges of Petroleum Mixtures) ([www.nj.gov/dep/srp/guidance/rs/petroleum\\_mixtures.pdf](http://www.nj.gov/dep/srp/guidance/rs/petroleum_mixtures.pdf)).
- “Guidance for the Issuance of Response Action Outcomes, Attachment 2” ([www.nj.gov/dep/srp/guidance/srra/rao\\_guidance.pdf](http://www.nj.gov/dep/srp/guidance/srra/rao_guidance.pdf)).

### **6.7.5 Remedial action verification**

After a remedial action has been conducted, to determine whether compliance with the applicable soil remediation standard has been achieved and no further action is warranted or whether additional remediation is required, either single-point compliance or compliance averaging can be used as detailed below.

#### **6.7.5.1 Direct contact exposure pathways**

Similar to the remedial investigation, determining compliance for direct contact exposure pathway soil remediation standards for the remedial action is dependent upon both the end use for the site or AOC, and whether the applicable direct contact soil remediation standard is determined by the ingestion-dermal exposure pathway or the inhalation exposure pathway.

For all soil remedial actions performed due to exceedances of either ingestion-dermal or inhalation direct contact exposure pathway remediation standards:

Any of the following compliance options can be used to determine if the remediation is complete for the ingestion-dermal and inhalation pathways:

- Single-point compliance
- Compliance averaging by calculating the arithmetic mean for the data set where there are two or fewer distinct sample values or nine or fewer total sample points
- Compliance averaging at the 95 percent UCL of the mean
- Compliance averaging using a spatially weighted average (e.g., Thiessen polygons)
- Compliance averaging using the 75 percent/10x procedure

It should be noted that compliance averaging cannot be performed on the sample results derived using the incremental sampling approach (Interstate Technology and Regulatory Council, February 2012, [www.itrcweb.org/ism-1/](http://www.itrcweb.org/ism-1/)) conducted in accordance with the February 2012

Department *Soil Investigation Technical Guidance - Site Investigation/Remedial Investigation/ Remedial Action (SI/RI/RA)* ([http://www.nj.gov/dep/srp/guidance/srra/soil\\_inv\\_si\\_ri\\_ra.pdf](http://www.nj.gov/dep/srp/guidance/srra/soil_inv_si_ri_ra.pdf)) (i.e., compliance for such samples is determined based on single point compliance).

See Appendix A for detailed guidance on compliance averaging using the arithmetic mean of the data set, compliance averaging at the 95 percent UCL of the mean, compliance averaging using a spatially weighted average, and compliance averaging using the 75 percent/10x procedure compliance options.

Other methods may be proposed by the investigator, where such an approach is relevant and appropriate to site conditions in the professional judgment of the investigator. Consultation with the Department is recommended if methods not discussed in this document are used.

The remedial action is considered complete for soils for the direct contact exposure pathways for the site or AOC if:

- single-point compliance is used and the concentration of each contaminant is less than or equal to its applicable direct contact exposure pathway soil remediation standard; or
- compliance averaging is used for appropriate ingestion-dermal and/or inhalation exposure pathway contaminants and the average contaminant concentration of each contaminant is less than or equal to its applicable direct contact exposure pathway soil remediation standard.

If the concentration of any contaminant exceeds its applicable direct contact exposure pathway soil remediation standard using either single-point compliance or compliance averaging, the person responsible for conducting the remediation can choose to either:

- Continue with the remedial action until the concentration of each contaminant is less than or equal to its applicable direct contact exposure pathway soil remediation standard; or
- Implement an institutional control and/or engineering control (if appropriate) pursuant to N.J.A.C. 7:26C-7. It should be noted that if an institutional control and/or engineering control is approved for the site, the person responsible for conducting the remediation will be responsible for all remedial action permit and remedial action protectiveness certification requirements pursuant to N.J.A.C. 7:26C-7, as well as all soil remedial action permit fees and obligations pursuant to N.J.A.C. 7:26C-4.6 and N.J.A.C. 7:26C-7, respectively.

The investigator still must demonstrate compliance with the impact to ground water exposure pathway soil remediation standards (see section 6.7.5.2 below).

#### **6.7.5.1.1 Unrestricted use soil remedial actions**

Pursuant to N.J.A.C. 7:26E-1.8, unrestricted use remedial action means “any remedial action that does not require the continued use of either engineering or institutional controls to meet the established health risk or environmental standards.”

Unrestricted use soil remedial actions are where contaminant concentrations are less than or equal to the most conservative direct contact exposure pathway soil remediation standard. This is determined by either single-point compliance or compliance averaging, as appropriate.

#### **6.7.5.1.2 Limited restricted use soil remedial actions**

Pursuant to the definition in the Technical Requirements (N.J.A.C. 7:26E-1.8), limited restricted use soil remedial actions do not apply to residential sites.

Limited restricted use soil remedial actions are where contaminant concentrations exceed the applicable residential soil remediation standard but are less than or equal to the applicable non-residential soil remediation standard. This is determined by either single-point compliance or compliance averaging, as appropriate.

For those areas not included within the institutional control, compliance in accordance with the section “Unrestricted Use Soil Remedial Actions” (6.7.5.1.1 above) is to be demonstrated.

#### **6.7.5.1.3 Restricted use soil remedial actions**

Pursuant to N.J.A.C. 7:26E-1.8, restricted use remedial action means “any remedial action that requires the continued use of engineering and institutional controls in order to meet the established health risk or environmental standards.”

By definition, restricted use soil remedial actions can apply to both residential and non-residential sites.

For residential uses, if the concentration of any contaminant exceeds its applicable direct contact exposure pathway residential soil remediation standard, then it will be necessary to establish both institutional and engineering controls pursuant to N.J.A.C. 7:26C-7.

For non-residential uses, if the concentration of any contaminant exceeds both its applicable direct contact exposure pathway residential and non-residential soil remediation standards, then it will be necessary to establish both institutional and engineering controls pursuant to N.J.A.C. 7:26C-7.

Those areas not included within an engineering control are restricted to non-residential uses, provided that concentrations do not exceed the applicable non-residential soil remediation standard.

For those areas not included within the institutional control, compliance in accordance with the section “Unrestricted Use Soil Remedial Actions” (6.7.5.1.1 above), is to be demonstrated.

### **6.7.5.2 Impact to ground water exposure pathway**

Any of the following compliance options can be used to determine if the remediation is complete for the impact to ground water pathway:

- Single-point compliance
- Compliance averaging by calculating the arithmetic mean for the data set where there are two or fewer distinct sample values or nine or fewer total sample points
- Compliance averaging at the 95 percent UCL of the mean
- Compliance averaging using a spatially weighted average (e.g., Thiessen polygons)
- Compliance averaging using the 75 percent/10x procedure

It should be noted that compliance averaging cannot be performed on the sample results derived using the incremental sampling approach (Interstate Technology and Regulatory Council, February 2012, [www.itrcweb.org/ism-1/](http://www.itrcweb.org/ism-1/)) conducted in accordance with the February 2012 Department *Soil Investigation Technical Guidance - Site Investigation/Remedial Investigation/ Remedial Action (SI/RI/RA)* ([http://www.nj.gov/dep/srp/guidance/srra/soil\\_inv\\_si\\_ri\\_ra.pdf](http://www.nj.gov/dep/srp/guidance/srra/soil_inv_si_ri_ra.pdf)) (i.e., compliance for such samples is determined based on single point compliance).

See Appendix A for detailed guidance on compliance averaging using the arithmetic mean of the data set, compliance averaging at the 95 percent UCL of the mean, compliance averaging using a spatially weighted average, and compliance averaging using the 75 percent/10x procedure compliance options.

Other methods may be proposed by the investigator, where such an approach is relevant and appropriate to site conditions in the professional judgment of the investigator. Consultation with the Department is recommended if methods not discussed in this document are used.

The remedial action is considered complete for soils for the impact to ground water pathway for the site or AOC if:

- single-point compliance is used and the concentration of each contaminant is less than or equal to its applicable impact to ground water exposure pathway soil remediation standard; or
- compliance averaging is used and the average contaminant concentration of each contaminant is less than or equal to its applicable impact to ground water exposure pathway soil remediation standard.

If the concentration of any contaminant exceeds its applicable impact to ground water pathway soil remediation standard using either single-point compliance or compliance averaging, the person responsible for conducting the remediation shall continue with the remedial action until the concentration of each contaminant is less than or equal to its applicable impact to ground water pathway soil remediation standard.

If the concentration of each contaminant is less than or equal to its applicable impact to ground water soil remediation standard, then the remedial action is complete for soils for the impact to ground water exposure pathway for the site or AOC. The investigator still must demonstrate compliance with the direct contact exposure pathways soil remediation standards as described above.

If the concentration of any contaminant exceeds the applicable impact to ground water soil remediation standard, then additional remedial action is required at the site or AOC.

Every effort must be made to remediate soils to the applicable impact to ground water soil remediation standards, except where technically impracticable. Engineering controls, such as capping, generally may not be used in lieu of remediation to address this exposure pathway.

NOTE: For sites that consist of historic fill that extend beyond the property boundary, it is not necessary to remediate soils to the impact to ground water exposure pathway soil remediation standard(s) for those contaminants associated with the historic fill.

## **7.0 Ground water**

### **7.1 Ground water remediation standards**

For each contaminant detected in ground water at the site or AOC, the investigator is to select the ground water remediation standard pursuant to N.J.A.C. 7:26D-2 for the ground water classification where the site or AOC is located and the discharge or the impact of the discharge occurs. This includes Class I (exceptional ecological areas; Pinelands), Class II (potable), and Class III (aquifers; salt water intrusion) ground waters, as defined pursuant to N.J.A.C. 7:9C-1.5. Numeric criteria for Class II-A ground waters are as indicated at N.J.A.C. 7:9C-1.7(c). Narrative standards are used to determine numeric criteria for Class I and III ground waters per N.J.A.C. 7:9C-1.7(a), (b), (e) or (f), as applicable. Note that pursuant to N.J.A.C. 7:26D-2.2(b), alternative remediation standards for ground water are not allowed.

In Class II-A ground water, for contaminants that do not have a standard listed as above, see the Ground Water Quality Standards at N.J.A.C. 7:9C-1.7(c)2 through 6 for the process for developing interim ground water quality standards.

### **7.2 Vapor intrusion exposure pathway**

Ground water screening levels for the vapor intrusion exposure pathway are discussed in the Department guidance “Vapor Intrusion Technical Guidance” ([www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm](http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm)). See section 7.3.2 regarding averaging of ground water analytical results to determine whether a vapor intrusion investigation is triggered.



## **7.3 Compliance**

### **7.3.1 General**

The investigator is to use single-point compliance to determine compliance with the applicable ground water remediation standards for all phases of investigation (site investigation, remedial investigation, and remedial action). Compliance averaging over spatial areas as allowed for soils is not allowed for ground water. The averaging process for ground water described in the following sections is applicable only to ground water samples collected from a single sampling location over a limited time period.

### **7.3.2 Site investigation**

If there are no exceedances of the applicable ground water remediation standards for any contaminants, then no further action is required for ground water at the site or AOC relative to the ground water remediation standards.

If the concentration of any contaminant in any ground water sample exceeds its applicable ground water remediation standard, the ground water may be resampled to confirm the presence of contamination. Two confirmation samples should be collected evenly spaced and using similar purging and sampling techniques within 60 days of the initial sample and the results averaged with the original result to determine compliance with the applicable standard. It should be noted that if the initial result is more than three times (3x) the applicable ground water standard or screening level, averaging is not allowed for demonstrating attainment of the applicable numerical standard or screening level (for example, if the initial result is more than three times the vapor intrusion ground water screening level, a vapor intrusion investigation is triggered). If the average does not exceed the applicable ground water remediation standard, then no further action is required for ground water at the site or AOC.

The user is directed to the Department's "Vapor Intrusion Technical Guidance" ([www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm](http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm)) regarding additional compliance issues for the vapor intrusion pathway.

If the concentration of any contaminant in any ground water sample exceeds its applicable ground water remediation standard, then the person responsible for conducting the remediation is required to conduct a remedial investigation of ground water for the site or AOC pursuant to N.J.A.C. 7:26E-4 and the Department's ground water technical guidance, "Ground Water Technical Guidance: Site Investigation/Remedial Investigation/Remedial Action Performance Monitoring" ([www.nj.gov/dep/srp/guidance/srra/gw\\_inv\\_si\\_ri\\_ra.pdf](http://www.nj.gov/dep/srp/guidance/srra/gw_inv_si_ri_ra.pdf)).

### **7.3.3 Remedial investigation**

Horizontal and vertical delineation for ground water will be considered complete for the site or AOC when ground water contaminant concentrations in the perimeter monitoring wells are less than or equal to the applicable ground water remediation standard for each contaminant present. This applies to all ground water impacted by contamination originating from the site or AOC.

If the initial concentration of any contaminant originating from the site or AOC in any ground water delineation sample exceeds its applicable ground water remediation standard, the ground water may be resampled to confirm the presence of contamination. Two confirmation samples should be collected evenly spaced and using similar purging and sampling techniques within 60 days of the initial perimeter sample and the results averaged with the original result to determine compliance with the applicable standard. It should be noted that if the initial result is more than three times (3x) the applicable ground water standard or screening level, averaging is not allowed for demonstrating attainment of the applicable numerical standard or screening level (for example, if the initial result is more than three times the vapor intrusion ground water screening level, a vapor intrusion investigation is triggered). If the average does not exceed the applicable ground water remediation standard, then ground water delineation is considered to be complete at the site or AOC.

If the ground water contaminant concentration in any perimeter sample exceeds its applicable ground water remediation standard, then the investigator is to continue to collect ground water samples until delineation is completed pursuant to the preceding paragraphs, or select an appropriate method to demonstrate delineation is completed. This applies both horizontally and vertically, as appropriate, to all ground water impacted by contamination originating from the site or AOC.

Once ground water delineation is complete, a Classification Exception Area (CEA) is required to be established pursuant to N.J.A.C. 7:26E-4.9 and N.J.A.C. 7:26C-7 for all ground water impacted by contamination originating from the site or AOC.

#### **7.3.4 Remedial action**

Pursuant to N.J.A.C. 7:26E, ground water contaminated above the applicable ground water remediation standards needs to be remediated. In most situations, this requires some form of remedial action (i.e., active or passive (monitored natural attenuation (MNA))); establishment of a CEA; and issuance of a Ground Water Remedial Action Permit.

If the concentration of any contaminant exceeds its applicable ground water remediation standard, then the ground water remedial action will not be considered complete, and the person responsible for conducting the remediation is to continue with the ground water remedial action until compliance with applicable ground water remediation standards is achieved at all locations within the site monitoring well network. A CEA and a Ground Water Remedial Action Permit are to remain in effect until compliance with the applicable ground water remediation standards is achieved at all locations within the site monitoring well network.

Compliance with the ground water remediation standards is achieved for the site or AOC when the concentration of each contaminant is less than or equal to its applicable ground water remediation standard for two consecutive confirmatory sampling events for all locations within the applicable ground water monitoring well network. Refer to N.J.A.C. 7:26C-7.9(f) for the requirements for conducting the confirmation sampling and removal of the CEA.

For the two confirmatory sampling events, if the concentration of any contaminant in any ground water sample within the ground water monitoring well network exceeds its applicable ground water remediation standard, the ground water may be resampled to confirm the presence of contamination for that specific sampling event. Two additional samples should be collected evenly spaced and using similar purging and sampling techniques within 60 days of the initial confirmatory sample and the results averaged with the original result to determine compliance with the applicable standard. It should be noted that if the initial result is more than three times (3x) the applicable ground water standard or screening level, averaging is not allowed for demonstrating attainment of the applicable numerical standard or screening level. If the average does not exceed the applicable ground water remediation standard, then ground water at that monitoring well is considered to be in compliance for that confirmatory sampling event.

The user is directed to the Department's "Vapor Intrusion Technical Guidance" ([www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm](http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm)) regarding additional compliance issues for the vapor intrusion pathway.

## **8.0 Surface water**

### **8.1 Surface Water Quality Standards**

For each contaminant originating from the site or AOC detected in surface water or in ground water samples collected immediately adjacent to surface water (and where it has been demonstrated that ground water is discharging into surface water), the investigator is to select human health-based surface water remediation standards pursuant to N.J.A.C. 7:26D-3. The surface water remediation standards should be selected based on the surface water classification applicable to where the discharge and impacts occur. Note that pursuant to N.J.A.C. 7:26D-3.2(b), alternative remediation standards for surface water are not allowed.

### **8.2 Ecological surface water screening levels**

Ecological surface water screening levels are discussed in the Department "Ecological Evaluation Technical Guidance" ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)).

## **8.3 Compliance**

### **8.3.1 Site investigation**

The investigator is to use single-point compliance to determine compliance with the applicable surface water remediation standards during the site investigation. If there are no exceedances of the applicable surface water remediation standards for any contaminants originating from the site or AOC, then no further action is required for surface water at the site or AOC relative to the surface water remediation standards. However, it is still necessary to determine whether there are exceedances of any surface water screening levels for the ecological evaluation of the site or AOC; refer to the Department "Ecological Evaluation Technical Guidance" ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)).

If the concentration of any contaminant originating from the site or AOC exceeds its applicable surface water remediation standard in any surface water sample, then the investigator is to conduct a remedial investigation of surface water for the site or AOC pursuant to N.J.A.C. 7:26E-4.4 and the Department's "Ecological Evaluation Technical Guidance" ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)).

### **8.3.2 Remedial investigation**

If the investigator chooses to use single-point compliance for the remedial investigation of surface water, then the remedial investigation will be considered complete when surface water contaminant concentrations that are originating from the site or AOC are less than or equal to the applicable surface water remediation standard for each contaminant present.

Alternative methods for determining compliance can be applied on a site-specific basis using applicable technical guidance as specified in the Site Remediation Reform Act (SRRA, N.J.S.A. 58:10C-14c).

If concentrations of contaminants originating from the site or AOC detected in surface water exceed the applicable surface water remediation standard, then the investigator is to continue to collect surface water samples until the remedial investigation is completed pursuant to the preceding paragraph. The investigator should consult the Department's "Ecological Evaluation Technical Guidance" ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)) or other applicable technical guidance as specified in SRRA.

### **8.3.3 Remedial action**

The investigator is to determine whether the surface water remedial action is protective of human health and of the environment, and whether additional remediation or no further action is required for surface water. As with the remedial investigation, either single-point compliance or an alternative compliance method may be used.

If the concentration of each contaminant originating from the site or AOC is less than or equal to its applicable surface water remediation standard, then the surface water remedial action will be considered complete. However, it is still necessary to determine whether there are exceedances of any surface water screening levels for the ecological evaluation of the site or AOC; refer to the Department "Ecological Evaluation Technical Guidance" ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)).

If the concentration of any contaminant originating from the site or AOC exceeds its applicable surface water remediation standard, then the surface water remedial action will not be considered complete, and the investigator is to continue with the surface water remedial action until compliance with the applicable surface water remediation standards is achieved for all contaminants originating from the site or AOC.

## **9.0 Extractable Petroleum hydrocarbons**

Requirements for investigations of extractable petroleum hydrocarbons (EPH) are found in the Department guidance document “Protocol for Addressing Extractable Petroleum Hydrocarbons” ([www.nj.gov/dep/srp/guidance/srra/eph\\_protocol.pdf](http://www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf)) in effect as of the date the report is submitted. The user is directed to this guidance document for information regarding how to select and/or develop the applicable remediation standards for petroleum hydrocarbons.

## **10.0 Ecological**

Requirements for conducting ecological investigations are found in the Technical Requirements, at N.J.A.C. 7:26E-1.16 and N.J.A.C. 7:26E-4.8. Additional guidance is found in the Department “Ecological Evaluation Technical Guidance” ([www.nj.gov/dep/srp/guidance/srra/ecological\\_evaluation.pdf](http://www.nj.gov/dep/srp/guidance/srra/ecological_evaluation.pdf)) in effect as of the date the report is submitted. The user is directed to this guidance document for information regarding how to select and/or develop the applicable remediation standards for ecological evaluations.

## **11.0 Vapor intrusion**

The primary guidance for investigations of the vapor intrusion pathway is the Department “Vapor Intrusion Technical Guidance” ([www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm](http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm)) in effect as of the date the report is submitted. The user is directed to this guidance document for information regarding how to select and/or develop the applicable remediation standards for the various media involved in a vapor intrusion investigation.

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## **Appendix A**

### **Compliance Averaging Options for the Ingestion-Dermal, Inhalation, and Impact to Ground Water Pathways**

## APPENDIX A

### Compliance Averaging Options for the Ingestion-Dermal, Inhalation, and Impact to Ground Water Pathways

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## **A1.0 Compliance Averaging Using the Arithmetic Mean**

Compliance averaging using the arithmetic mean is only to be applied in those situations where there are two or fewer distinct sample values or nine or fewer total sample points.

To determine the arithmetic mean value of the data set, add up all the sample values, and divide by the total number of samples. For non-detect (ND) values, enter zero (0) as the value. The rationale for entering zero is two-fold: (a) there is a preference to not ascribe a data value where there is no evidence that such a datum exists, and (b) to be consistent with the guidance provided by the ProUCL software that one-half of the detection level (i.e., "DL/2") not be used for non-detect values. While the median value option may be preferentially selected by statisticians (as opposed to the arithmetic mean value), the arithmetic mean value is to be used as a measure of conservatism to avoid the allowance of hot spots to go unremediated.

## **A2.0 Compliance Averaging at the 95 percent Upper Confidence Limit of the Mean**

As indicated in sections 6.7.4.1, 6.7.4.2, 6.7.5.1 and 6.7.5.2, compliance averaging at the 95 percent Upper Confidence Limit (UCL) can be conducted for all exposure pathways in the remedial investigation and/or the remedial action phases. If this compliance option is to be used in the remedial investigation phase, complete horizontal and vertical delineation using single point compliance, must first be completed. Pursuant to N.J.A.C. 7:26E-3.4(a), sampling shall be biased towards the AOC, and shall not include excessive sampling of uncontaminated areas. For the purposes of this document, "excessive sampling" is considered as more than the minimum needed to complete the delineation as defined by N.J.A.C. 7:26E.

To determine compliance with the applicable soil remediation standard, the investigator can estimate the average of the sample concentrations at the 95 percent UCL, using appropriate statistical methods. These calculations should be performed by a person qualified in statistical analysis. The use of the software application ProUCL is suggested. Statistics manuals provide recommendations for minimum number of samples needed for this type of analysis. Too few samples may result in an unrealistically high estimate and may call the validity of the analysis into question. Therefore, a minimum of 10 samples are required for the use of the 95 percent UCL.

To estimate a compliance average that is protective of human health and the environment, an appropriate application area (functional area) must be first defined, using the procedures discussed below. Once the functional area has been defined, the average can be estimated as described in A2.1.4, Evaluation of Functional Areas, below.

### **A2.1 Functional areas**

The use of functional areas facilitates the process of evaluating contaminated areas of the site. The purpose of the functional area is to help select the samples to be included in the compliance averaging process. Compliance averaging using the 95 percent UCL of the mean concentration employs a fixed area approach ("functional area").

## **Ingestion-Dermal and Inhalation Pathways**

For the ingestion-dermal and inhalation pathways the “functional areas” correspond to the areas of typical residential and non-residential sites, as well as constraints placed on the models involved. To the degree practicable, the placement of the initially assessed functional area shall be biased to the worst case contaminant concentrations for the ingestion-dermal and inhalation pathways.

For example, if the site is five acres in size, but contamination is limited to only two acres, only this two acre portion of the site requires evaluation. To determine whether to use the residential or non-residential functional area, land use should be taken into account. The investigator then assesses whether there is an exceedance of the remediation goal within each individual functional area.

## **Impact to Ground Water Pathway**

For the impact to ground water exposure pathway, the functional area is based on the size of the AOC. The relevant dimension is the length of the AOC in the direction parallel to ground water flow. There is no constraint on the length of the AOC in the direction perpendicular to ground water flow.

### **A2.1.1 Size of functional area**

#### **Inhalation Pathway**

The functional area for residential exposure scenarios will be 0.5 acre for residential exposure scenarios, and two (2) acres for non-residential exposure scenarios. For the explanation of how these functional area sizes were developed, refer to Appendix G - Site Size Justification of the document “Inhalation Exposure Pathway Soil Remediation Standards Basis and Background, June 2008 ([www.nj.gov/dep/srp/regs/rs/bb\\_inhalation.pdf](http://www.nj.gov/dep/srp/regs/rs/bb_inhalation.pdf)).

If more than one functional area is to be evaluated, and the contaminated areas of the site cannot be divided exactly, the size of the final functional area to be evaluated can be increased by up to 50 percent (note - functional areas are to be evaluated on a “worst case first” basis; see A2.1.4, Evaluation of Functional Areas below, for more details). Examples are as follows:

Residential site - functional area = 0.5 acres

- Site size is 0.75 acres, the entire site can be evaluated as one functional area
- Site size is 1.2 acres, would require two functional areas, the first being 0.5 acres, the second 0.7 acres

Non-residential site - functional area = 2.0 acres

- Site size is 3.0 acres, the entire site can be evaluated as one functional area.
- Site size is 4.3 acres, would require two functional areas, the first being 2.0 acres, and the second 2.3 acres

Similarly, if the site size is less than 0.5 acres for a residential site or less than 2 acres for a non-residential site, the functional area is applied, and the applicable residential or non-residential Inhalation Soil Remediation Standard applied.

### **Ingestion-Dermal Pathway**

The functional area for residential exposure scenarios will be 0.25 acres. In the case of the non-residential exposure scenarios, the functional area will be two (2) acres, the default non-residential site lot size. The residential exposure scenario of 0.25 acres represents one-half of the residential lot size, and assumes that ingestion of contamination is occurring in either the front yard or the back yard of the residence.

If more than one functional area is to be evaluated, and the contaminated areas of the site cannot be divided exactly, the size of the final functional area to be evaluated can be increased by up to 50 percent (note - functional areas are to be evaluated on a “worst case first” basis; see A2.1.4, Evaluation of Functional Areas below, for more details). Examples are as follows:

Residential site - functional area = 0.25 acres

- Site size is 0.33 acre, the entire site can be evaluated as one functional area.
- Site size is 1.1 acres, would require four functional areas, three being 0.25 acres, and the fourth 0.35 acres

Non-residential site - functional area = 2.0 acres

- Site size is 2.3 acres, the entire site can be evaluated as one functional area.
- Site size is 4.3 acres, would require two functional areas, the first being 2.0 acres, and the second 2.3 acres

Similarly, if the site size is less than 0.25 acres for a residential site or less than 2 acres for a non-residential site, the default functional area is applied, and the applicable residential or non-residential Ingestion-Dermal Soil Remediation Standard applied.

### **Impact to Ground Water Pathway**

The functional area for the impact to ground water exposure pathway is defined by the area of concern (AOC). The length is defined as the part of the AOC parallel to ground water flow, and is not necessarily the longest dimension of the AOC. The 100 foot length is the AOC length value included in the dilution attenuation factor (DAF) equation utilized in the derivation of the

impact to ground water soil remediation screening levels found in Table 1 of the technical guidance document “Development of Site-Specific Impact to Ground Water Soil Remediation Standards Using the Soil-Water Partition Equation” ([www.nj.gov/dep/srp/guidance/rs/partition\\_equation.pdf](http://www.nj.gov/dep/srp/guidance/rs/partition_equation.pdf)).

For AOCs with a length up to and including 100 feet in the direction parallel to ground water flow, a length of 100 feet in the direction parallel to ground water flow can be used as the functional area if the investigator:

- Wants to use the impact to ground water soil screening levels found in Table 1 of the technical guidance document “Development of Site-Specific Impact to Ground Water Soil Remediation Standards Using the Soil-Water Partition Equation” ([www.nj.gov/dep/srp/guidance/rs/partition\\_equation.pdf](http://www.nj.gov/dep/srp/guidance/rs/partition_equation.pdf)); or
- Has already calculated a site-specific standard using a length of 100 feet in the direction parallel to ground water flow.

Delineated AOCs situated downgradient of each other whose total length (including “gaps” between AOCs) does not exceed 100 feet can be combined into a single functional area.

If the size of the AOC is larger than 100 feet in the direction parallel to ground water flow, the investigator can evaluate the AOC using:

- If the default DAF is used, multiple functional areas of 100 feet length in the direction parallel to the direction of ground water flow as described above. To the degree practicable, the placement of the initially assessed functional area shall be biased to the worst case contaminant concentrations; or
- The entire delineated AOC as the functional area. If this option is chosen, then a site-specific DAF and impact to ground water standard are to be calculated using the length of the entire AOC as the functional area parallel to the direction of ground water flow.

#### **A2.1.2 Shape of functional area**

##### **Ingestion-Dermal and Inhalation Pathways**

Pursuant to the existing “Guidance Document - Inhalation Standards Compliance - Development of Alternative Remediation Standards for the Inhalation Pathway”

([www.nj.gov/dep/srp/guidance/rs/compl\\_ars\\_inhalation.pdf](http://www.nj.gov/dep/srp/guidance/rs/compl_ars_inhalation.pdf)), the preferred shape of the functional area is that of a square (Figure 1 below) but can vary somewhat based on site configuration and contamination distribution. However, it is preferred that the length of the functional area be kept to no more than four times the width (Figure 2 below). For consistency, the same shape restrictions apply to both the ingestion-dermal and inhalation exposure pathways.

Figure 1: Preferred shape of functional area - square

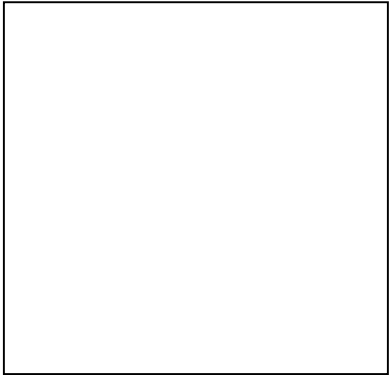


Figure 2: Maximum offset shape of functional area



### **Impact to Ground Water Pathway**

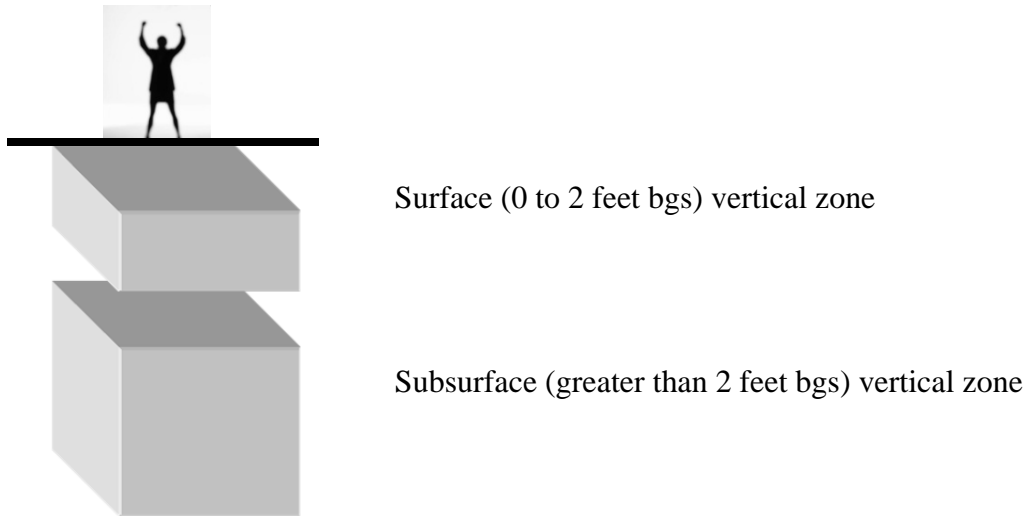
The shape of the functional area is based on the length of the AOC in the direction parallel to ground water flow (minimum length of 100 feet), and the delineated extent of contamination in all other directions.

#### **A2.1.3 Vertical definition of functional area**

##### **Ingestion-Dermal and Inhalation Pathways**

In all cases, there is a surface zone of 0 to 2 feet below ground surface (bgs) and one subsurface zone (greater than 2 feet bgs) associated with the site being evaluated (Figure 3). The surface zone will encompass both surface samples (0.0 to 0.5 feet) as well as any other samples taken at 2 feet of depth or less. The final vertical depth for the subsurface zone shall be determined pursuant to the delineation requirements set forth in N.J.A.C. 7:26E. These depth intervals are based on general assumptions on the potential and likelihood of soil disturbance. Based on the contaminant distribution pattern in both the surface and subsurface zones, the functional areas within the subsurface vertical zones may need to be placed and evaluated distinctly from the comparable functional areas within the surface vertical zone.

Figure 3: Vertical definition of functional area - ingestion-dermal and inhalation pathways

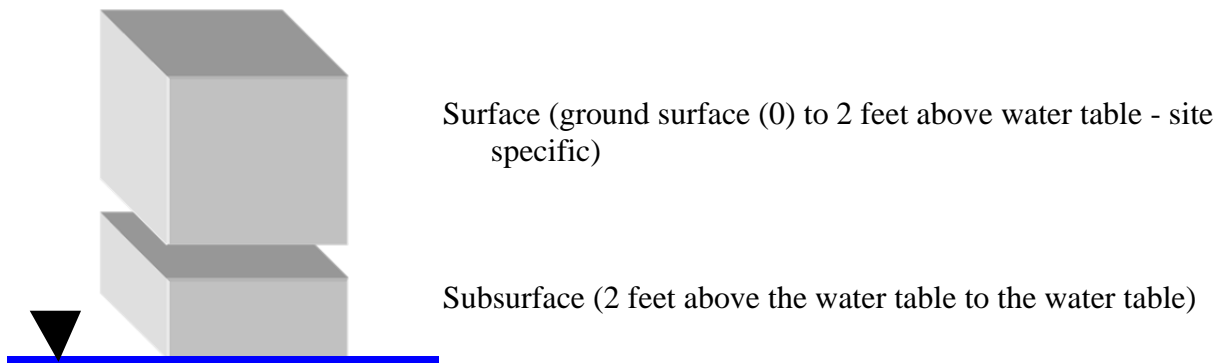


### Impact to Ground Water Pathway

For the impact to ground water pathway there will be two vertical zones. The first zone is from the ground surface to two (2) feet above the water table, and the second zone is from two (2) feet above the water table to the water table (Figure 4).

Unlike the direct contact pathways, the receptor for impact to ground water is the ground water. The depth intervals for these zones are based on this receptor. To address fluctuations in the water table and the impact the soil contamination could have on the ground water, the two foot zone above the water table zone was established. The remainder of the vadose zone, whose height is obviously site-specific, is designated as the first zone.

Figure 4: Vertical definition of functional area - impact to ground water pathway



#### **A2.1.4 Evaluation of functional areas**

In all cases, each individual contaminant detected in the vertical zones (surface, subsurface) is evaluated by comparing the 95 percent UCL of the mean of the selected data against the applicable standard. The data to be selected are to include those required to delineate the AOC encompassed by the functional area. Data below regulatory concern other than those needed to delineate the AOC would not be included. Data from AOCs that are not of regulatory concern also would not be included.

The 95 percent UCL of the mean approach is used by the United States Environmental Protection Agency (U.S. EPA) for situations where, from a statistical perspective, there is a limited amount of data for a given AOC or site. All data necessary for delineation within a given functional area and vertical zone(s) are utilized in the evaluation.

An algorithm that properly addresses non-detect results should be used to evaluate the data. The program ProUCL is widely used and can be downloaded from the U.S. EPA website (go to [www.epa.gov/osp/hstl/tsc/software.htm](http://www.epa.gov/osp/hstl/tsc/software.htm) for the most up-to-date version of this software). The investigator can elect to utilize other software, but they must provide documentation on the algorithm used, and the underlying assumptions and techniques employed.

If more than one potential UCL is identified by the algorithm used, the lower value should be used in the evaluation.

If the calculated UCL is greater than all values in the data set, the maximum sample value in the data set should be used for evaluation.

#### **A2.1.5 Offsite compliance**

##### **Ingestion-Dermal and Inhalation Pathways**

For the ingestion-dermal and inhalation pathways, if delineation indicates that contamination has migrated offsite at any depth, then delineation and compliance with the applicable soil remediation standard shall be determined by applying the most restrictive applicable standard to the offsite contaminated area. Pursuant to the Technical Requirements, contamination migrating offsite is to be delineated to the unrestricted use standard (N.J.A.C. 7:26E-4.2(a)2). Therefore, the contaminated offsite area shall be addressed separately and the 95 percent UCL of the mean of the offsite area compared to the most restrictive soil remediation standard, irrespective of its current land use.

If the functional area compliance evaluation for the offsite area indicates that there are no exceedances of the most stringent soil remediation standard in the worst case area, then no further remediation of the offsite contamination is required for either the ingestion-dermal or the inhalation exposure pathways. This does not preclude the need for additional remediation for the offsite area being evaluated based on the impact to ground water pathway. If the compliance evaluation for the offsite functional area indicates that there is an exceedance of the most restrictive soil remediation standard, a remedial action will be required; this may involve

removal, treatment, or establishment of an institutional control, with or without an engineering control.

### **Impact to Ground Water Pathway**

For the impact to ground water pathway, the functional area is defined by the associated AOC, which may extend across property boundaries.

### **A3.0 Compliance Averaging using a Spatially Weighted Average**

As indicated in sections 6.7.4.1, 6.7.4.2, 6.7.5.1 and 6.7.5.2, compliance averaging using a weighted average can be conducted for the all exposure pathways in the remedial investigation and/or the remedial action phases. If this compliance option will be used, complete horizontal and vertical delineation using single point compliance, is required for completion of the remedial investigation.

To determine compliance with the applicable soil remediation standard, a spatially weighted average (area weighted mean) may be used whereby the sampling results are weighted according to the area they represent. The corresponding area may be defined using Thiessen Polygons (also known as Voronoi or Dirichlet tessellations). Polygons define individual areas of influence around each of a set of points. Thiessen polygons are polygons whose boundaries define the area that is closest to each point relative to all other points; they are mathematically defined by the perpendicular bisectors of the lines between all points. These calculations are typically performed using CAD or GIS software<sup>1</sup>, or can be performed manually. The results of each sample are adjusted for the percentage of the overall area the corresponding sample represents, and the adjusted values are averaged.

The methods for determining the size of the functional area and for the vertical subsurface zones to be used for the analyses are the same as defined for the 95 percent UCL of the mean in sections A2.1.1 (size) and A2.1.3 (vertical definition) above. As with the 95 percent UCL of the mean, the size and vertical definition of the functional area will be determined by the appropriate exposure pathway (ingestion/dermal and inhalation, or impact to ground water).

The spatial analysis must be performed within each of the vertical zones within which contaminant concentrations exceed the applicable remediation standard. If multiple samples exist within a single vertical zone (e.g., 2 feet through 12 feet bgs), the greatest concentration within that zone should be used in the analysis. For sites greater in size than the functional area (0.25 acres for residential and 2 acres for commercial/industrial land uses), multiple functional areas may be defined. To the degree practicable, the placement of the initially assessed functional area shall be biased to the worst case contaminant concentrations.

To apply the spatially weighted average method, an iterative analysis is typically performed for each contaminant that exceeds the applicable remediation standard; this is illustrated in Figures 5 through 9 for a hypothetical contaminant in the surface zone (0 to 2 feet bgs). In these figures,

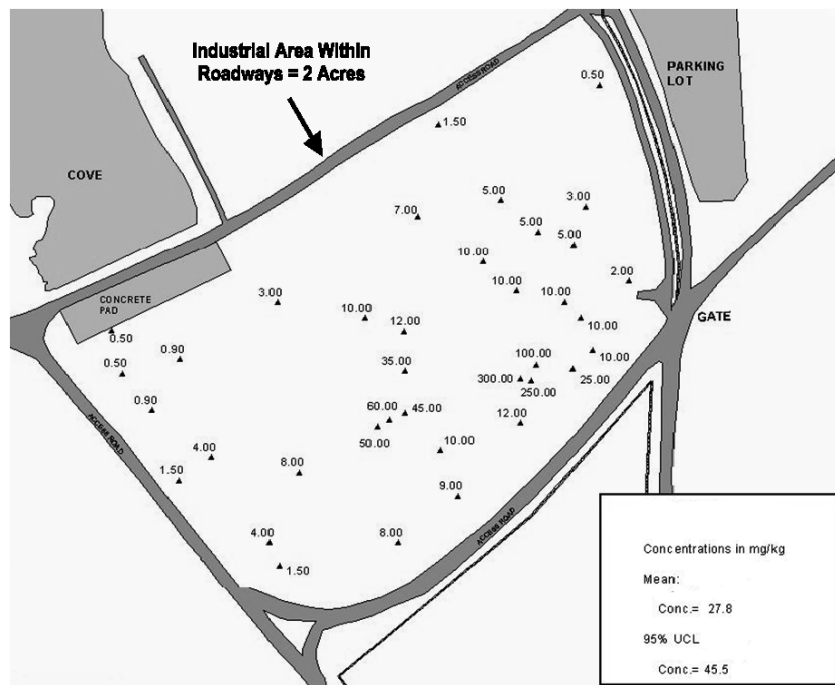
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<sup>1</sup> For example, in ESRI ARCVIEW, by selecting ArcToolbox > Analysis Tools > Proximity > Create Thiessen Polygons.



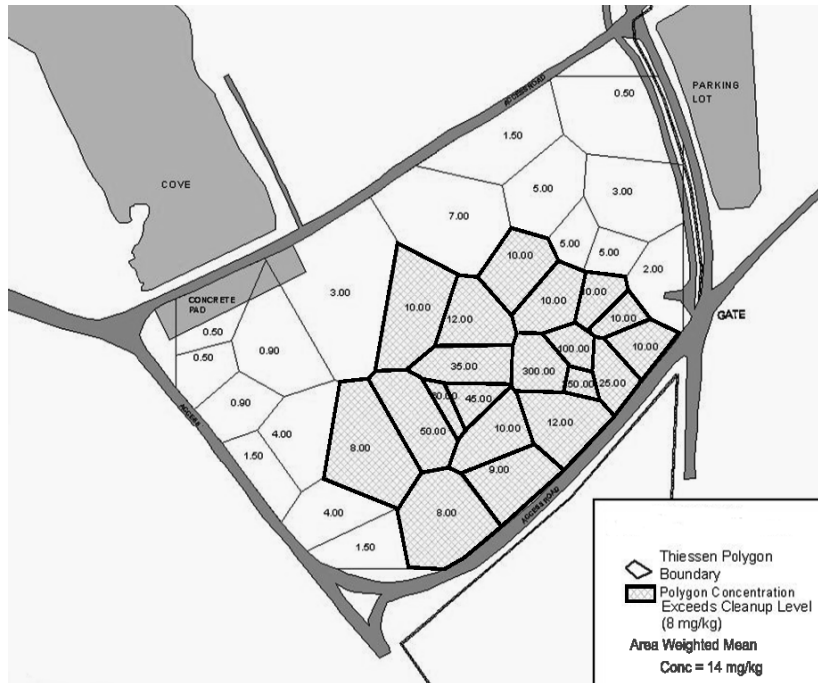
the entire industrial site is approximately two (2) acres (representing the functional area for compliance averaging), and the applicable remediation standard is 8 mg/kg. In the first step, the data points are plotted (Figure 5). In the second step, the polygon boundaries are determined and the initial area weighted mean concentration is calculated (Figure 6). If this initial area weighted mean concentration is below the applicable remediation standard, then no further action is required. If this initial area weighted mean concentration is above the applicable remediation standard, then appropriate remedial action(s) must be evaluated. The first step in this evaluation is to replace the most highly contaminated polygon with a fill or background concentration, and then recalculate the area weighted mean concentration (Figure 7). For non-detect values, the reporting limit should be used. This process continues progressively with the next most contaminated polygon(s) until the area weighted mean for the functional area is at or below the applicable remediation standard (Figures 8 and 9). All polygons “removed” (replaced with actual analytical data for the fill, or, if such data are not available, a background concentration) as part of this evaluation are required to be remediated. For unrestricted use, “removed” polygons would be remediated to the fill or background concentration used in the calculation of the area weighted mean concentration. For limited restricted and restricted use, “removed” polygons would be subject to institutional and possibly engineering controls, as well as a remedial action permit for soil.

Figure 5: Location and concentration of surficial (0 - 2 feet) soil samples



Source: Anderson and Samuelian, 2000

Figure 6: Delineation of Thiessen polygons indicating associated areal concentrations



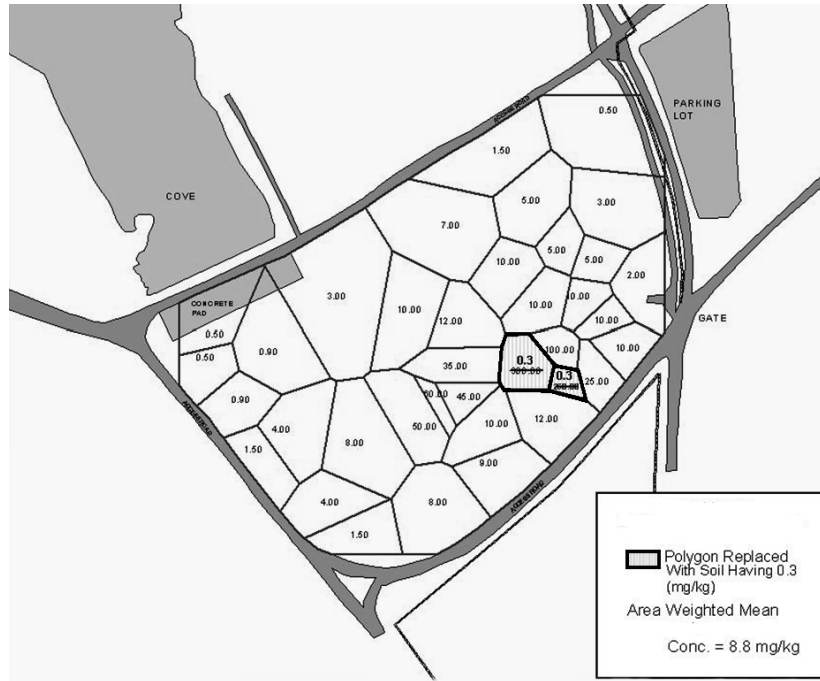
Source: Anderson and Samuelian, 2000

Figure 7: Iteration 1 - replacement of greatest concentration polygon with “background” concentration



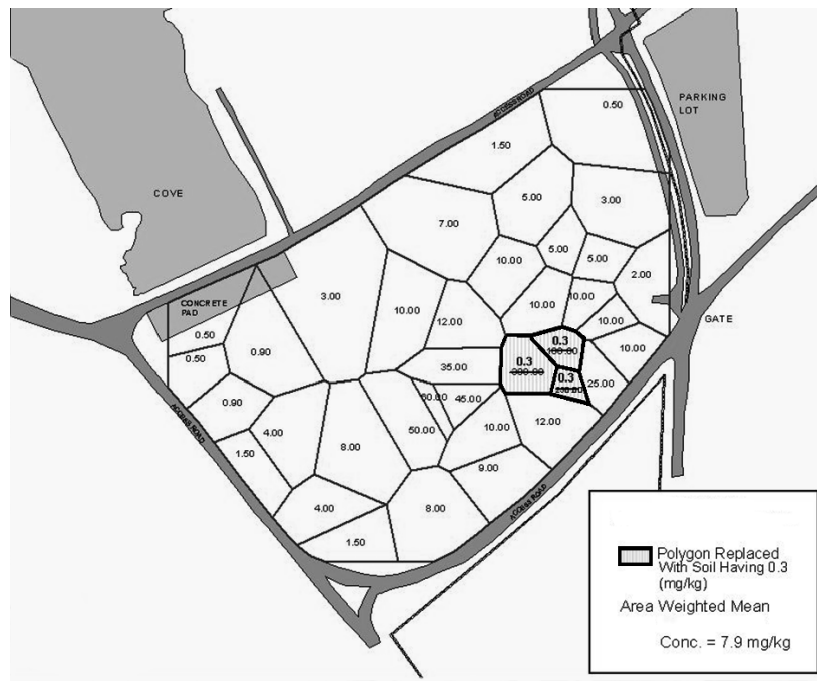
Source: Anderson and Samuelian, 2000

Figure 8: Iteration 2 - replacement of next greatest concentration polygon with “background” concentration



Source: Anderson and Samuelian, 2000

Figure 9: Iteration 3 - replacement of next greatest concentration polygon with “background” concentration



Source: Anderson and Samuelian, 2000

#### **A4.0 Compliance Averaging using the 75 percent/10x Procedure**

As indicated in section 6.7.5.1 and 6.7.5.2, compliance averaging using the 75/10x procedure can only be conducted for the soil ingestion-dermal, inhalation and the impact to ground water exposure pathways after a remedial action has been conducted. This sampling scheme has been used successfully by the Pennsylvania Department of Environmental Protection (see Pennsylvania Department of Environmental Protection “Technical Guidance Manual” (June 8, 2002).

A minimum of eight post-remedial samples are required per AOC for this compliance option to be utilized. Any smaller sample populations cannot use this method. The sample number is also based on the volume of soil excavated. In order to use this compliance option, 8 post-remedial samples are required for up to 125 cubic yards of excavated soil; 12 post-remedial samples for up to 3,000 cubic yards; and 12 additional samples for each soil volume up to 3,000 cubic yards thereafter. In addition, all collected samples used to demonstrate compliance must be collected within the zone of impact from the contaminants of concern. For example, if impacts above remediation standards were found at depths ranging from 2 to 4 feet and overlying soils were not impacted above standards, all samples used to demonstrate compliance must be taken from the 2 to 4 foot depth interval.

If 75 percent of all post-remedial samples are below the applicable soil remediation standard and none of the remaining samples exceed the applicable standard by an order of magnitude (10x), the remedial action is considered to have met the remedial objective and no further action is necessary.

## **Appendix B**

### **Glossary**

## GLOSSARY

The following definitions are to be used throughout this guidance document. Where appropriate, definitions are referenced to existing definitions in the Technical Requirements (N.J.A.C. 7:26E-1.8; [www.nj.gov/dep/rules/rules/njac7\\_26e.pdf](http://www.nj.gov/dep/rules/rules/njac7_26e.pdf)).

“Applicable remediation standard” means the standard selected for the site, based on but not limited to the remediation standard as defined at N.J.A.C. 7:26D-1.5 and/or site-specific criterion, site-specific conditions, intended future use of the site, and chosen remedial action (i.e., unrestricted, limited restricted, restricted).

“Attainment of compliance” in general means the process by which analytical data from a site or area of concern are compared against all applicable remediation standards, and a determination made as to whether existing site conditions meet or exceed those standards. This process can be accomplished using either single-point compliance or compliance averaging.

“Compliance averaging” means determining compliance for the soil direct contact (ingestion-dermal, inhalation), soil impact to ground water, and ground water exposure pathways using the methodologies described in this document, including but not limited to the arithmetic mean, the 95 percent upper confidence limit (UCL) of the mean, spatially weighted averaging (e.g., Thiessen polygons), and the 75 percent/10x procedure.

“Contaminant of concern” means site-specific compounds associated with a discharge(s) at or from a site that are detected in environmental media (soil, ground water, surface water, sediment, air) above regulatory criteria. It also includes the degradation byproducts from the COCs.

“Direct contact” soil exposure pathways include both the ingestion-dermal exposure pathway and the inhalation exposure pathway.

“Functional area” means an area of fixed size which corresponds to the areas of typical residential and non-residential sites. The purpose of the functional area is to help select the samples to be included in the compliance averaging process.

“Limited restricted use remedial action” is as defined in the Technical Requirements (N.J.A.C. 7:26E-1.8).

“Restricted use remedial action” is as defined in the Technical Requirements (N.J.A.C. 7:26E-1.8).

“Single-point compliance” means the comparison of an analytical result from a single sample to each applicable remediation standard for each medium and exposure pathway, to determine whether contamination is present and additional remediation is required at the site or area of concern.

“Unrestricted use remedial action” is as defined in the Technical Requirements (N.J.A.C. 7:26E-1.8).

## **Appendix C**

### **Acronyms**

## ACRONYMS

AOC	area of concern
ARRCS	Administrative Requirements for the Remediation of Contaminated Sites
bgs	below ground surface
CEA	Classification Exception Area
CSM	conceptual site model
DAF	dilution attenuation factor
LNAPL	light non-aqueous phase liquid
LSRP	Licensed Site Remediation Professional
N.J.A.C.	New Jersey Administrative Code
N.J.S.A.	New Jersey Statutes Annotated
RA	Remedial action
RI	Remedial investigation
SI	Site investigation
SRRA	Site Remediation Reform Act
UCL	Upper Confidence Limit
U.S. EPA	United States Environmental Protection Agency