



# DNR REMEDIATION & REDEVELOPMENT PROGRAM GUIDANCE FOR PUBLIC COMMENT



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## DOCUMENT TRACKING NUMBER

RR-0152

## DOCUMENT TITLE

**Guidance: Soil Cleanup Standards (RR0152), Wis. Stat. § 292.12(5m)**

## BACKGROUND/SUMMARY

This publication provides guidance for persons who perform investigation and remediation of sites with contamination under Wisconsin Administrative (Wis. Admin.) Code chs. NR 700 – 799 and Wisconsin Statute (Wis. Stat.) ch. 292. Specifically, this guidance is intended for responsible parties, property owners, environmental consultants and attorneys involved with the investigation and remediation of soil contamination.

Wis. Admin. Code ch. NR 720 establishes soil cleanup standards for soil contamination. This guidance describes how to establish and apply soil cleanup standards at a site or facility where a hazardous substance discharge impacted the soil.

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## Soil Cleanup Standards Guidance (RR-0152)

### Wisconsin Administrative Code Ch. NR 720

#### Purpose

This guidance is for persons who perform investigation and remediation of sites with contamination under Wisconsin Administrative (Wis. Admin.) Code chs. NR 700 - 799 and Wisconsin Statute (Wis. Stat.) ch. 292. Specifically, this guidance is intended for responsible parties, property owners, environmental consultants and attorneys involved with the investigation and remediation of soil contamination.

Wis. Admin. Code ch. NR 720 establishes soil cleanup standards for soil contamination. This guidance describes how to establish and apply soil cleanup standards at a site or facility where a hazardous substance discharge impacted the soil.

#### Related Guidance

Wisconsin Department of Natural Resources (DNR) publications and forms referenced in this document include a number beginning with "RR-" or "4400-." Locate these publications and forms by visiting [dnr.wi.gov](http://dnr.wi.gov) and search for the number.

- *Consensus-Based Sediment Quality Guidelines* (RR-088)
- *Guidance: Contaminated Soil Quick Reference Table* (RR-106)
- *Guidance on Addressing Contaminated Sites in Wisconsin* (RR-0124)
- *Guidance: Soil Residual Contaminant Level (RCL) Spreadsheet* (RR-0151)
- *Guidance on the Use of Leaching Tests for Unsaturated Contaminated Soils to Determine Groundwater Contamination Potential* (RR-523)
- *Guidance on the Case Closure Process and Continuing Obligations* (RR-606)
- *Guidance for Determining Soil Contaminant Background Levels at Remediation Sites* (RR-721)
- *Wisconsin Statewide Soil-Arsenic Background Threshold Value* (RR-940)
- *Guidance: Post Closure Modifications* (RR-982)
- *Compliance Averaging of Soil Contaminant Concentration Data* (RR-991)
- *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request form* (Form 4400-237)

Find additional DNR guidance on soil cleanup by visiting [dnr.wi.gov](http://dnr.wi.gov) and searching "soil cleanup."

This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

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## 1 Introduction

### 1.1 Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
ALM	Adult Lead Model
ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BGS	below ground surface
BRRTS	Bureau for Remediation and Redevelopment Tracking System
BTV	background threshold value
CCR	cumulative cancer risk
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CO	continuing obligation
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
C <sub>sat</sub>	soil saturation concentration
DAF	dilution attenuation factor
DC-RCL	direct contact residual contaminant level
DHS	Wisconsin Department of Health Services
DNR	Wisconsin Department of Natural Resources
ES	enforcement standard
GW	groundwater
GW-RCL	groundwater residual contaminant level
ISM	incremental sampling methodology
HI	hazard index
HQ	hazard quotient
ITRC	Interstate Technology Regulatory Council
LOD	limit of detection
LOQ	limit of quantitation
MCL	maximum contaminant level
ND	not detected
PAHs	polycyclic aromatic hydrocarbons
PAL	preventive action limit
PFAS	per- and polyfluoroalkyl substances
PCBs	polychlorinated biphenyls
QA/QC	quality assurance/quality control
RBA	relative bioavailability
RCL	residual contaminant level
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RL	reporting limit
RP	responsible party
RPD	relative percent difference
RR Program	Remediation and Redevelopment Program
RSL	regional screening level
RSL Calculator	Regional Screening Level Calculator
SHWMU	solid or hazardous waste management unit
SS-RCL	site-specific residual contaminant level

<b>U.S. EPA</b>	U.S. Environmental Protection Agency
<b>VOC</b>	volatile organic compound
<b>Wis. Admin. Code</b>	Wisconsin Administrative Code
<b>Wis. Stat.</b>	Wisconsin Statutes

## 1.2 Definitions

### Background soil quality is:

- Soil quality that is attributable to the parent material from which the soil was derived and the natural processes which produce soil, or from contamination attributable to atmospheric deposition including the following constituents: lead, polynuclear aromatic hydrocarbons, or polychlorinated biphenyls, but not attributable to hazardous substance discharges or the discharge of pollutants, as that phrase is defined in Wis. Stat. § 283.01.
- Soil quality that is found at or within reasonable proximity to the site or facility, at a depth comparable to that of the area to be remediated, in the same soil layer and in an area unaffected by hazardous substances discharges or the discharge of pollutants. (Wis. Admin. Code § NR 700.03(2))

**Background threshold value (BTV)** is the concentration that represents the upper range of background concentrations.

**Ceiling limit concentration** means a preset non risk-based concentration of an inorganic or semi-volatile chemical. Note: This definition is consistent with the approach used in the U.S. Environmental Protection Agency's (U.S. EPA) *Regional Screening Table* which sets a ceiling limit concentration of 100,000 milligrams per kilogram (mg/kg) or 10% by weight for a relatively non-toxic chemical in a soil sample. (Wis. Admin. Code § NR 720.03(1m) and accompanying note to the rule)

**Continuing obligations (COs)** are property-specific responsibilities that are established either before or after the state approves an environmental cleanup, and that apply to the property regardless of changes of ownership. Continuing obligations include but are not limited to environmental limitations or conditions established in the state's closure approval letter. (Wis. Admin. Code § NR 714.03(2)) COs may be imposed at the time of approval of interim actions, remedial actions, or case closure, pursuant to Wis. Stat. § 292.12(2).

**Cumulative excess cancer risk** means the upper bound on the estimated excess cancer risk associated with exposure to multiple hazardous substances or multiple exposure pathways. (Wis. Admin. Code § NR 720.03(3))

**Dermal absorption** means systemic exposure via skin absorption. However, because dermal toxicity factors are not available, oral-to-dermal extrapolation is done by adjusting for gastrointestinal absorption to derive toxicity values in terms of a dermally absorbed dose. (Wis. Admin. Code § NR 720.03(3m))

**Direct contact** means human exposure to substances in soil through one or more of the following pathways: inhalation of particulate matter, dermal absorption, incidental ingestion, or inhalation of vapors from the soil. (Wis. Admin. Code § NR 720.03(4))

**Direct contact residual contaminant level (DC-RCL)** is a soil cleanup standard developed in accordance with Wis. Admin. Code § NR 720.12 and based on protection of human health from direct contact with contaminated soil.

- Industrial direct contact RCL is a soil cleanup standard used for industrial land uses

- b. Non-industrial direct contact RCL is a soil cleanup standard used for nonindustrial land uses such as commercial and residential settings

**Discharge** means, but is not limited to, spilling, leaking, pumping, pouring, emitting, emptying or dumping. (Wis. Stat. § 292.01(3))

**Enforcement standard (ES)** means a numerical value expressing the concentration of a substance in groundwater which is adopted under Wis. Stat. § 160.07 and Wis. Admin. Code § NR 140.10 or Wis. Stat. § 160.09 and Wis. Admin. Code § NR 140.12. (Wis. Admin. Code § NR 140.05(7))

**Engineering control** means an object or action designed and implemented to contain contamination or to minimize the spread of contamination, including a cap, soil cover, or in-place stabilization, but not including a sediment cover. (Wis. Stat. § 292.01(3m))

**Environment** means any plant, animal, natural resource, surface water (including underlying sediments and wetlands), groundwater, drinking water supply, land surface and subsurface strata, and ambient air within the state of Wisconsin or under the jurisdiction of the state of Wisconsin. (Wis. Admin. Code § NR 700.03(18))

**Environmental pollution** means the contaminating or rendering unclean or impure the air, land, or waters of the state, or making the same injurious to public health, harmful for commercial or recreational use, or deleterious to fish, bird, animal or plant life. (Wis. Stat. § 292.01(4))

**Environmental standards** mean those cleanup standards, performance standards, standards of control and other substantive and procedural requirements, criteria or limitations promulgated as a regulation or rule under or pursuant to federal environmental or state environmental or facility citing laws that specifically address a hazardous substance, pollutant, remedial action, location or other circumstances found at a site or facility. (Wis. Admin. Code § NR 700.03(20))

**Groundwater** means "any waters of the state, as defined in Wis. Stat. § 281.01(18) occurring in a saturated subsurface geological formation of rock or soil." See "waters of the state" definition in Wis. Admin. Code § NR 700.03(67). (Wis. Admin. Code §§ NR 160.01(4) and NR 700.03(23))

**Groundwater quality standards** mean site-specific standards developed pursuant to Wis. Admin. Code ch. NR 140 and groundwater quality standards adopted by the DNR in Wis. Admin. Code ch. NR 140, including enforcement standards, preventive action limits, indicator parameters and alternative concentration levels. (Wis. Admin. Code § NR 700.03(24))

**Groundwater pathway residual contaminant level (GW-RCL)** is a soil cleanup standard developed in accordance with Wis. Admin. Code § NR 720.10 and based on protection of groundwater.

**Hazard index (HI)** means the sum of two or more hazard quotients for multiple hazardous substances or multiple exposure pathways. (Wis. Admin. Code § NR 720.03(5))

**Hazard quotient** means the ratio of the exposure of a single hazardous substance over a specified time period to a reference dose, or reference concentration where appropriate, for that hazardous substance derived for a similar exposure period. Note: Hazard quotients and hazard indices are measures of the potential for noncarcinogenic effects. (Wis. Admin. Code § NR 720.03(6) and accompanying note to the rule)

**Hazardous substance** means any substance or combination of substances including any waste of a solid, semisolid, liquid or gaseous form which may cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness or which may pose a substantial present or potential hazard to human health or the environment because of its quantity, concentration or physical, chemical or infectious characteristics. This term includes, but is not limited to, substances which are toxic, corrosive, flammable, irritants, strong sensitizers or explosives as determined by the DNR. (Wis. Stat. § 292.01(5))

**Incidental ingestion of soil** means ingestion of soil by humans as a result of normal hand-to-mouth behaviors. (Wis. Admin. Code § NR 720.03(7))

**Industrial land use** means the utilization of a parcel of real estate for manufacturing operations that use machinery and mechanical power to produce products or services, including electrical power, or for a service business that provides storage facilities, product distribution or maintenance or repair services for machinery. Note: Examples of industrial land uses include manufacturing and assembly plants; warehouses; scrap salvage operations; foundries and forging plants; metal pressing, stamping and spinning plants; electroplating facilities; tanneries; chemical processing facilities; electrical generating plants and electrical substations; slaughter houses and meat processing plants; fertilizer and pesticide packaging plants; bottling plants; wholesale bulk fuel storage and distribution facilities; railroad yards; and businesses that sell and repair motor vehicles, recreational vehicles, transportation containers or construction machinery and equipment. (Wis. Admin. Code § NR 700.03(28m) and accompanying note to the rule)

**Inhalation of particulate matter** means inhalation by humans of contaminants adsorbed to respirable soil particles less than 10 microns in diameter. (Wis. Admin. Code § NR 720.03(8))

**Inhalation of vapors** means inhalation by humans of soil contaminants that volatilized into outdoor air. (Wis. Admin. Code § NR 720.03(9m))

**J-flag** is a data quality qualifier that means the analytical result is an estimated concentration between the limit of detection and the limit of quantitation.

**Limit of detection (LOD)** means the lowest concentration or amount of analyte that can be identified, measured, and reported with confidence that the concentration is not a false positive value. For DNR purposes, the LOD approximates the method detection limit (MDL) and is determined by the method cited in Wis. Admin. Code § NR 149.03(46) (MDL). (Wis. Admin. Code §§ NR 700.03(30g) and NR 149.03(41))

**Limit of quantitation (LOQ)** means the lowest concentration or amount of an analyte for which quantitative results can be obtained. (Wis. Admin. Code §§ NR 700.03(30r) and NR 149.03(42))

**Migration pathway** means natural geologic features or cultural features, including but not limited to water mains, sewage laterals, drain tiles and roadbeds, which allow the movement of a hazardous substance or environmental pollution in liquid, solid, dissolved or vapor phase. (Wis. Admin. Code § NR 700.03(34))

**Naturally occurring background** means the quality of individual media in the vicinity of a discharge of a hazardous substance or environmental pollution that has not been affected by a hazardous substance discharge or environmental pollution. (Wis. Admin. Code § NR 700.03(39))

**Non-industrial land use** is any land use that is not industrial, such as commercial and residential settings.

**Non-residential setting** means a setting other than a residential setting, used for commercial or industrial purposes. (Wis. Admin. Code § NR 700.03(39m))

**Pathway** means the route a substance takes in traveling to a receptor or potential receptor or the specific portal of entry, such as lungs, skin or digestive tract, that the substance takes to potentially express its toxic effect, or both. (Wis. Admin. Code § NR 700.03(42m))

**Performance standard** means a remedial action or, in some cases existing site conditions that prevent exposure to contaminants or will result in a decrease in contaminant concentrations, or both. (Wis. Admin. Code § NR 720.03(12m))

**Practicable** means capable of being implemented, considering:

- a. The technical feasibility of a remedial action option, considering its long-term effectiveness, short-term effectiveness, implementability and the time it will take until restoration is achieved; and
- b. The economic feasibility of a remedial action option, considering the cost of the remedial action option compared to its technical feasibility. (Wis. Admin. Code § NR 700.03(45))

**Receptors** are environmental resources, including but not limited to, plant and animal species and humans, sensitive environments and habitats, water supply wells, and buildings or locations that have the potential to be, or have actually been, exposed to contamination. (Wis. Admin. Code § NR 700.03(47))

**Regional screening levels (RSLs)** are the U.S. EPA's screening levels derived using the U.S. EPA Regional Screening Level Calculator.

**Remedial action** or "remedy" means those response actions, other than immediate or interim actions, taken to control, minimize, restore, or eliminate the discharge of hazardous substances or environmental pollution so that the hazardous substances or environmental pollution do not present an actual or potential threat to public health, safety, or welfare or the environment. The term includes actions designed to prevent, minimize, stabilize, or eliminate the threat of discharged hazardous substances, and actions to restore the environment to the extent practicable and meet all applicable environmental standards. Examples include storage, disposal, containment, treatment, recycling, or reuse, and any monitoring required to assure that such actions protect public health, safety, and welfare and the environment. (Wis. Admin. Code § NR 700.03(48))

**Residential setting** means any dwelling designed or used for human habitation, and includes educational, childcare, and elder care settings. (Wis. Admin. Code § NR 700.03(49g))

**Residual contaminant level (RCL)** is the numerical soil cleanup level for a substance that is determined in accordance with Wis. Admin. Code §§ NR 720.10 or NR 720.12. RCLs may be determined based on protection of human health from direct contact with contaminated soil (direct contact RCL) or based on protection of groundwater (groundwater RCL).

**Residual contamination** means that some contamination remains after a cleanup is completed and approved. Residual contamination includes all phases of remaining contamination including vapor, dissolved, adsorbed, and free phase. (Wis. Admin. Code § NR 700.03(49r))

**Responsible party (RP)** means any of the following (Wis. Admin. Code § NR 700.03(51)):

- a. Any person who is required to conduct a response action under Wis. Stat. ch. 292.
- b. Persons liable to reimburse the DNR for the costs incurred by the DNR to take response action under Wis. Stat. chs. 289 and 292.
- c. Owners and operators of solid waste facilities that are subject to regulation under Wis. Admin. Code ch. NR 508.

**Risk** means the probability that a hazardous substance, when released to the environment, will cause carcinogenic effects in exposed humans or other biological receptors. (Wis. Admin. Code § NR 720.03(14))

**Risk assessment** means a site-specific characterization of the current or potential threats that may be posed to public health, safety, or welfare or the environment by contamination migrating to or in groundwater or surface water, discharging to the air, leaching through or remaining in soil, bioaccumulating in the food chain, or other exposure pathways. (Wis. Admin. Code § NR 700.03(53))

**Sediment** means particles in the bed of a navigable water up to the ordinary high water mark that are derived from the erosion of rock, minerals, soil, and biological materials and from chemical precipitation from the water column and that are transported or deposited by water. (Wis. Stat. § 292.01(17g))

**Soil** means unsaturated organic material derived from vegetation and unsaturated, loose, incoherent rock material, of any origin, that rests on bedrock other than foundry sand, debris and any industrial waste. (Wis. Admin. Code § NR 700.03(58))

**Soil cleanup standard** means either a residual contaminant level determined in accordance with Wis. Admin. Code §§ NR 720.10 or 720.12, or a soil performance standard determined in accordance with Wis. Admin. Code § NR 720.08. (Wis. Admin. Code § NR 720.03(15))

**Soil saturation concentration or  $C_{sat}$**  means the contaminant concentration in soil at which the absorptive limits of the soil particles, the solubility limits of the soil particles, the solubility limits of the soil pore-water, and saturation of soil pore-air have been reached. At concentrations greater than  $C_{sat}$ , the soil contaminant may be present in free phase for contaminants that are liquid at ambient soil temperatures and pure solid phases for compounds that are solid at ambient soil temperatures. (Wis. Admin. Code § NR 720.03(16))

### 1.3 Units and Nomenclature

Abbreviation	Meaning
$C_{coc}$	concentration, contaminant of concern
$C_{sat}$	soil saturation concentration
mg/kg	milligrams per kilogram
ng/kg	nanograms per kilogram
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
$\mu\text{g}/\text{kg}$	micrograms per kilogram

## 2 Applicability

Soil cleanup standards apply to remedial actions to address soil contamination at sites and facilities, including the following:

- Sites and facilities subject to regulation under Wis. Stat. ch. 292, including sites listed on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Solid waste facilities where remedial action is required pursuant to Wis. Admin. Code ch. NR 508
- Hazardous waste facility closures or Resource Conservation and Recovery Act (RCRA) corrective actions
- Wastewater lagoons, storage structures, and treatment structures that are abandoned pursuant to Wis. Admin. Code §§ NR 110.09, NR 213.07 or NR 214.08
- Properties where remedial action is being taken by a person who is seeking the voluntary party liability exemption under Wis. Stat. § 292.15
- Sites and facilities with polychlorinated biphenyl (PCB) contamination
- State-funded cleanup actions

Soil cleanup standards also apply to interim actions when case closure will be requested in accordance with Wis. Admin. Code ch. NR 726, without taking a remedial action to address the contaminated soil.

### Exemption for Pesticides

Soil cleanup standards do not apply to pesticides that are applied in compliance with applicable state and federal regulations (see Wis. Admin. Code § NR 720.02(4) for specific conditions).

For sites subject to RCRA, investigation results are compared with soil cleanup standards to determine if a remedial action is necessary. This includes sites where the investigation occurred under a hazardous waste closure plan related to closure of a facility or hazardous waste management unit or a RCRA facility investigation report developed in accordance with the requirements of subchs. G and H of Wis. Admin. Code ch. NR 664 or § NR 664.0100. The soil cleanup standards apply to:

- A facility's closure plan developed as a part of its operating license to outline how residual contamination will be addressed upon facility closure
- A disposal facility's long-term care requirements
- Corrective actions required for discharges from regulated units and other areas of concern

### 3 General Requirements

#### 3.1 Remedial Action

When a site investigation indicates soil contamination is present at levels exceeding soil cleanup standards, a remedial action is necessary (Wis. Admin. Code § NR 720.05(1)).

When remedial actions are conducted and the residual soil contamination meets residual contaminant levels (RCLs) and/or performance standards established for the site, additional remedial actions may be required if the residual soil contamination will present a threat to human health or the environment, or cause violations to groundwater, surface water, or air quality standards (Wis. Admin. Code § NR 720.05(3)).

#### 3.2 Residual Contaminant Levels or Performance Standards

A soil cleanup standard can be either a **residual contaminant level (RCL)** or a **performance standard** (Wis. Admin. Code § NR 720.03(15)).

- An **RCL** is a numerical soil cleanup level for a substance that is determined in accordance with Wis. Admin. Code §§ NR 720.10 or NR 720.12. RCLs may be determined based on protection of human health from direct contact with contaminated soil (direct contact RCL) or based on protection of groundwater (groundwater RCL).
- A **performance standard** is a remedial action or existing site condition that prevents exposure to contaminants or will result in a decrease in contaminant concentrations and is determined in accordance with Wis. Admin. Code § NR 720.08. An example of a performance standard is a concrete cap that prevents direct contact with contaminated soil.

Responsible parties design and implement remedial actions to restore contaminated soil to levels that, at a minimum, comply with the RCLs and/or performance standards for the site or facility.

#### 3.3 Land Use Classifications

The land use classification of a site or facility determines what direct contact RCLs and soil performance standards are applied. Two main classifications are used – **industrial land use** and **non-industrial land use**; site-specific land use classifications may also be considered. The land use classification is based on the current land use and zoning for the site at the time the remedial action is selected and may also consider future land use and uses of nearby properties.

##### 3.3.1 Industrial Land Use Classification

Industrial direct contact RCLs apply to sites and facilities with an **industrial land use classification** (Wis. Admin. Code § NR 720.12). A site is considered industrial if the site or facility is currently zoned or officially designated for industrial use (for example, through a conditional use permit that allows industrial use in a non-industrial zoning district or other county development or municipal master plans that designate an area for industrial use).

If industrial direct contact RCLs are used at a site or facility, restrictions on future use of the site or facility may be imposed (i.e., limiting the land use to industrial purposes) at the time of approval of an interim action, remedial action or site closure (Wis. Stat. § 292.12(2) and Wis. Admin. Code § NR 726.15(2)(g)).

An industrially zoned property could be required to meet more stringent non-industrial direct

contact RCLs if it is adjacent to residential areas (Wis. Admin. Code § NR 720.05(5)(b)(2)).

A responsible party may choose to clean up a site or facility with an industrial land use classification to more stringent non-industrial direct contact RCLs.

### **3.3.2 Non-Industrial Land Use Classifications**

Non-industrial direct contact RCLs apply to sites and facilities with a **non-industrial land use classification**. This includes a variety of land uses, including residential, commercial, recreational, and many other types of land use that don't fit the definition of industrial land use.

### **3.3.3 Site-Specific Land Use Classifications**

If the site or facility has a unique land use, it may be possible to apply site-specific direct contact RCLs for that specific land use. Alternative exposure assumptions used to determine a site-specific direct contact RCL must be approved in advance by the DNR (Wis. Admin. Code § NR 720.12(2)).

## **3.4 Direct Contact with Soil**

Humans in direct contact with contaminated soil may experience adverse health impacts. The potentially accessible soil interval for direct contact with contaminated soil is considered the top four feet (0 to 4 feet below ground surface (bgs)). However, there may be cases where site-specific factors, such as the type and concentration of contaminants present, current use of the site, or potential future uses of the site, support a direct contact interval greater than 4 feet bgs. For example, site building construction or work on buried utility lines could create conditions where soil greater than 4 feet bgs is accessible and therefore represents a direct contact risk.

When contaminant concentrations in soil are less than the DC-RCLs, no remedial action is needed to address human health impacts from direct contact with contaminated soil. Sites with contaminants exceeding DC-RCLs will require remedial action to address direct contact with contaminated soil. In some circumstances, soil performance standards may be used to address direct contact with contaminated soil.

## **3.5 Groundwater Pathway**

Contaminants in soil can migrate to groundwater. Concentrations of contaminants in soil from the ground surface to the depth of the lowest water table elevation observed during the site investigation are evaluated, in conjunction with site geological conditions, and compared to GW-RCLs to determine if there is a potential for soil contaminants to impact groundwater. If soil concentrations exceed GW-RCLs, then groundwater sampling will be required at the site to assess groundwater conditions, unless other site characteristics can be used to rule out the groundwater pathway. Site characteristics may include vertical delineation of contamination in soil, depth to groundwater, soil properties and other information that affects the potential for soil contaminants to leach to groundwater.

## **3.6 Documentation of Soil Cleanup Standards**

Site investigation reports and draft remedial action options reports must document how soil cleanup

standards were established (Wis. Admin. Code § NR 720.05(4)).<sup>1</sup> The submittal must include sufficient background information, supporting documentation and data to support that the procedures selected to establish the soil cleanup standards are valid for the site or facility. (Wis. Admin. Code § 720.05(4)).

### 3.7 DNR Approvals

DNR approvals are required in the following situations related to this guidance:

- Use of a site-specific GW-RCL or an alternate method to establish GW-RCLs (Wis. Admin. Code § NR 720.10(2))
- Use of a site-specific DC-RCL or an alternate method to establish DC-RCLs (Wis. Admin. Code § NR 720.12(2))
- Use of a risk assessment to establish site-specific cleanup levels (Wis. Admin. Code § NR 722.11(1))
- Use of composite soil sample data (Wis. Admin. Code § NR 716.13(4))
- Use of averaged soil contaminant data (Wis. Admin. Code § NR 720.07(2)(b))
- Use of a site-specific soil background concentration as the RCL (Wis. Admin. Code § NR 720.07(3)).
- Modifications to continuing obligations (Wis. Stat. § 292.12(6); Wis. Admin. Code § NR 727.09)

Use the *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request* form (4400-237) to request DNR approval. Submit the request with the required fee (Wis. Admin. Code ch. NR 749).

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<sup>1</sup> Unless otherwise directed by the DNR

## 4 Requirements When Establishing RCLs

### 4.1 General Requirements

It is necessary to evaluate whether soil contamination exists at concentrations that pose a potential human health risk from direct contact with contaminated soil or at concentrations that could result in groundwater contamination. Depending on the conceptual site model, it may also be necessary to evaluate the potential for impacts to ecological resources from soil contamination. If soil contaminant concentrations result in the need for a remedial action, responsible parties need to establish soil cleanup standards for each soil contaminant of concern at the site for each exposure scenario and migration pathway (Wis. Admin. Code § 720.07(1)(a)). The RCL for a soil contaminant is the lowest concentration from among the following factors (Wis. Admin. Code § 720.07(1)(b)(1)):

- A land use specific direct contact RCL
- A groundwater quality protective (i.e. soil to groundwater pathway) RCL
- A value protective of other pathways such as human food chain, surface water quality, or terrestrial ecological pathways
- The chemical's ceiling limit concentration
- The chemical's soil saturation concentration ( $C_{sat}$ , for volatile contaminants)

In accordance with Wis. Admin. Code § NR 720.07(1)(c), when a remedial action is conducted to meet the selected RCL, or if a soil performance standard is utilized to address soil contamination, the action must not result in residual soil contamination that:

- Adversely affects surface water or a sensitive environment
- Allows for bioaccumulation in the food chain
- Results in vapor concentrations reaching a chemical's lower explosive limit

### 4.2 Laboratory Methods and Reporting

Use a laboratory certified in Wisconsin for the method selected.<sup>2</sup> The limit of detection (LOD) and the limit of quantitation (LOQ) must be included in the laboratory report, and the results reported on a dry weight basis. When possible, both the LOD and LOQ for the method selection should be at or below the RCLs. Please consult with the DNR project manager if you have questions about analytical methods. (See Wis. Admin. Code § NR 720.07(2)).

When comparing the sample results to the RCLs, the LOD, LOQ and laboratory qualifier J must be considered to determine if a soil standard has been exceeded (Wis. Admin. Code § NR 720.07(2)).

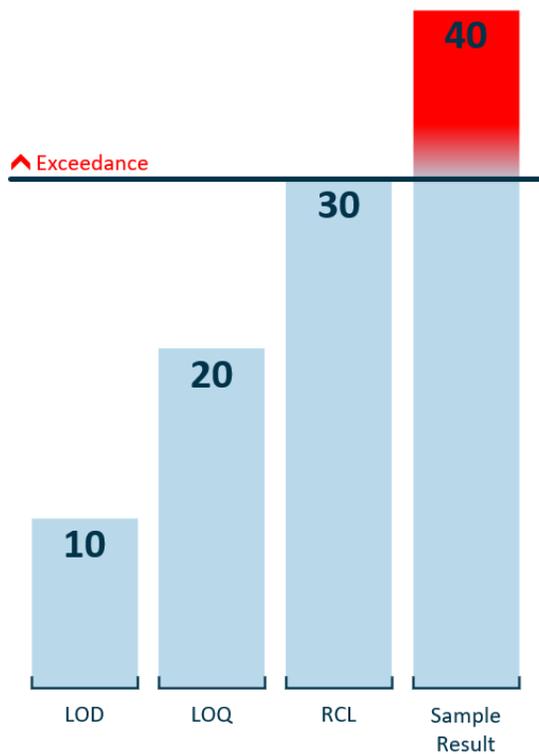
#### Additional Resources

The Interstate Technology Regulatory Council (ITRC) includes information on soil sample preparation methodology and analytical methods in its *Soil Background and Risk Assessment* guidance document (<https://sbr-1.itrcweb.org/>).

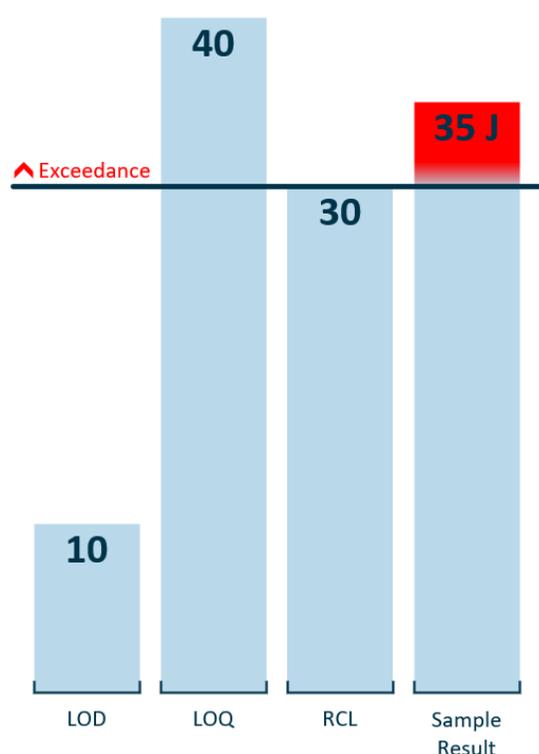
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<sup>2</sup> When using a method certified in Wisconsin.

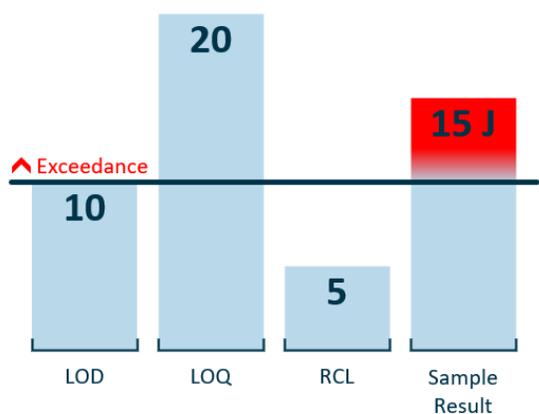
Figure 1. Comparing sample results to the RCL



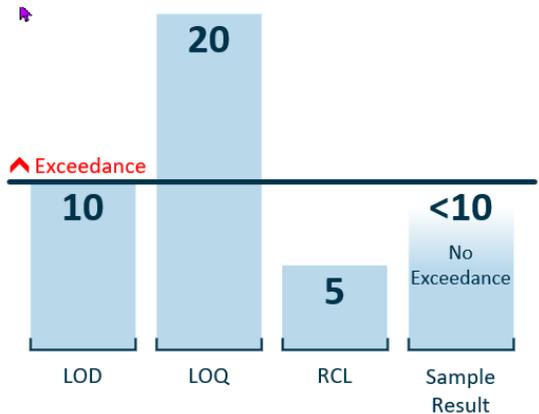
The soil cleanup standard is exceeded when the sample result is greater than the LOD, LOQ and RCL.



The soil cleanup standard is exceeded when the sample result is estimated (i.e., J-flagged) above the RCL.



The soil cleanup standard is exceeded when the sample result is estimated (i.e., J-flagged) above the RCL and LOD.



The soil cleanup standard is not exceeded when the sample result is below the LOD.

Sample results, the LOD and LOQ may be affected by matrix interference, sample dilution, sample preparation method, lab contamination, etc. If it is difficult to interpret the analytical results, it may be necessary to resample and reanalyze using a different analytical method or lab preparation method. Consult with the analytical laboratory to discuss and resolve any sample quality issues.

### 4.3 Soil Background Concentrations

A responsible party has the option to establish background concentrations of contaminants in soil (Wis. Admin. Code § 720.07(3)). The background concentration of a contaminant in soil is represented by a soil background threshold value (BTV), which represents the upper range of the background concentrations in soil for a specific contaminant. The range of background concentrations includes both naturally occurring concentrations as well as anthropogenic ambient concentrations from atmospheric deposition. When a background concentration (represented by a BTV) is established using a method approved by the DNR, and its value is higher than the RCL, the background value may be used as the RCL for that substance. The background concentration may also be based upon BTVs available in the *Soil RCL Spreadsheet* (RR-0151) (Wis. Admin. Code § NR 720.07). See Section 8.5 for more information on establishing and using background concentrations.

### 4.4 Application of Soil RCLs to Sediment

**Sediment** means particles in the bed of a navigable water up to the ordinary high water mark that are derived from the erosion of rock, minerals, soil, and biological materials and from chemical precipitation from the water column and that are transported or deposited by water. (Wis. Stat. § 292.01(17g)).

**Soil** means unsaturated organic material derived from vegetation and unsaturated, loose, incoherent rock material, of any origin, that rests on bedrock other than foundry sand, debris and any industrial waste. (Wis. Admin. Code § NR 700.03(58))

Sites adjacent to or that include waterways or wetlands may include both contaminated sediment and soil. DC-RCLs may be applied to floodplain soils and sediments below the ordinary high-water mark to assess the potential for human health risk from direct contact with contaminated sediments. Additionally, it may be possible to calculate site-specific DC-RCLs to determine appropriate cleanup levels for floodplain soils and sediment if there is a potential for human health risk from direct contact with these materials.

Additional guidance on evaluation and cleanup of contaminated sediment may be found in *Guidance on Addressing Contaminated Sediment Sites in Wisconsin* (RR-0124) and *Consensus-Based Sediment Quality Guidelines* (RR-088).

## 5 Procedures for Establishing Groundwater RCLs

RCLs based on protection of groundwater (GW-RCLs) are determined using the enforcement standard (ES) as the target groundwater concentration (Wis. Admin. Code § NR 720.10(1)). When an ES for a chemical of concern is not established, options for selecting a target groundwater concentration may include:

- Using a proposed ES from the Wisconsin Department of Health Services (DHS) or state health advisory level
- Using a Risk-Based Regional Screening Level (RSL) for tap water from U.S. EPA RSL Calculator (RSL Calculator)
- Developing a site-specific groundwater target concentration in consultation with the DHS and in compliance with Wis. Stat. §§ 160.13 and 160.15 and the criteria in Wis. Admin. Code § NR 722.09(2)(b)(2)
- Utilizing health-based advisory levels or other levels developed by the U.S. EPA, Agency for Toxic Substances and Disease Registry (ATSDR), or other appropriate agencies, as determined by the DNR
- Using the U.S. EPA's maximum contaminant level (where there is no DHS recommended ES)

Consult with the DNR project manager to determine the best approach for determining a GW-RCL for a contaminant without an established ES.

Responsible parties may determine a site-specific GW-RCL or an alternate method to establish GW-RCLs if approved by the DNR in writing (Wis. Admin. Code § NR 720.10(2)).

Use the *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request* form (4400-237) to request DNR approval of a site-specific GW-RCL or to use an alternate method to establish GW-RCLs. Under Section 3, check the box for **Approval of a Site-Specific Soil Cleanup Standard**.

### 5.1 Deriving GW-RCLs Using the Regional Screening Level Calculator

The DNR uses the RSL Calculator to determine GW-RCLs. The DNR maintains a list of default GW-RCLs in its *Soil RCL Spreadsheet* (RR-0151). GW-RCLs for common contaminants are also summarized in the *RCL Quick Reference Table* (RR-106).

#### U.S. EPA RSL Calculator

For more information and instructions for calculating GW-RCLs using the RSL Calculator, see Appendix A.

#### 5.1.1 Default GW-RCLs

Default GW-RCLs are calculated using the RSL Calculator and selecting the **Soil to Groundwater** scenario. The RSLs are converted to GW-RCLs by replacing the MCL with the ES as the target groundwater concentration and applying a dilution attenuation factor (DAF) of 2 (the RSL calculator assumes a DAF of 1).

#### 5.1.2 Site-Specific GW-RCLs

Site-specific information may be used with the RSL Calculator to derive site-specific GW-RCLs. This may be helpful if a RP would like to use a site-specific DAF, or if the default GW-

RCL is not considered protective based on specific receptors at the site.

A site-specific DAF may be used to calculate a site-specific GW-RCL using the **Dilution Factor for Migration to Groundwater Equations and Parameters** input screen within the RSL Calculator. To calculate a site-specific DAF, site-specific information including the hydraulic conductivity of the aquifer, the hydraulic gradient, annual infiltration rate, the thickness of the groundwater mixing zone, and the length of the plume as delineated by Wis. Admin. Code ch. NR 140 Preventive Action Limits (PALs) is needed.

## 5.2 Deriving GW-RCLs Using Other Methods

Other methods may be used to establish site-specific GW-RCLs including a contaminant fate and transport model or leaching tests following the DNR's *Guidance on the Use of Leaching Tests for Unsaturated Contaminated Soils to Determine Groundwater Contamination Potential* (RR-523) (Wis. Admin. Code § NR 720.10(2)).

### 5.2.1 Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

The DNR is not using the RSL Calculator to derive GW-RCLs for perfluoroalkyl and polyfluoroalkyl substances (PFAS). The simple leaching and dilution model used by the calculator is overly simplistic and not appropriate for PFAS. PFAS often occur in mixtures and have unique physical and chemical properties which affect their fate and transport in the subsurface. The DNR recommends that any site with detectable concentrations of PFAS in soil needs to evaluate the groundwater pathway.

### 5.2.2 Pesticides

Results from the RSL Calculator are not applied to agricultural pesticides. When determining RCLs for pesticides, label rates, restrictions, and safety factors imposed by the DNR or DATCP must be followed. The *Memorandum of Understanding Between the Wisconsin Department of Agriculture, Trade & Consumer Protection and Wisconsin Department of Natural Resources* applies to discharges of pesticide products intended for use by private and commercial applicators and the general public, including historical discharges of pesticides. DATCP is the lead agency providing oversight of investigation and cleanup of discharges of agricultural pesticides. The MOU provides information on agricultural pesticides and maximum allowable concentrations in soil. More information on cleanup of agricultural pesticides is included in the MOU and on DATCP's Agricultural Chemical Cleanup Program webpage ([https://datcp.wi.gov/Pages/Programs\\_Services/ACCP.aspx](https://datcp.wi.gov/Pages/Programs_Services/ACCP.aspx)). The DATCP also provides a standard analyte list for agricultural pesticide sites (<https://datcp.wi.gov/Documents/ACCPAnalytesLabs.pdf>). The MOU does not apply to products that are not fertilizers or registered pesticides that are discharged at a pesticide manufacturing site.

## 6 Procedures for Establishing Direct Contact RCLs

RCLs based on protection of human health from direct contact (DC-RCLs) are established using the following target risk levels established in Wis. Admin. Code § NR 720.12(1):

- Excess cancer risk of  $1 \times 10^{-6}$  for individual carcinogenic compounds
- Hazard quotient (HQ) of one for individual non-carcinogenic compounds
- Cumulative excess cancer risk of  $1 \times 10^{-5}$  for all carcinogenic compounds at the site or facility
- Hazard index (HI) of one for all non-carcinogenic compounds at the site or facility

When applying the target risks in Wis. Admin. Code § NR 720.12(1) to carcinogenic PAHs (cPAHs), it is appropriate to exclusively use cumulative cancer risk targets to assess carcinogenic PAHs in soil. At the request of the DNR, the DHS completed a reassessment of risk associated with cPAHs and an evaluation of the methods used by the DNR to determine direct contact RCLs for cPAHs.

The following criteria were considered during the reassessment of risks:

- cPAHs are found as a mixture of many PAH compounds, not as singular compounds
- cPAHs have similar effects on human health and may be evaluated as a group

Based on the reassessment findings, the cumulative assessment of cPAHs may be used to ensure protectiveness of human health and the environment. The use of a cumulative assessment of cPAHs, known as the cumulative cancer risk approach, is considered an alternate approach for determining standards exceedances (Wis. Admin. Code § NR 720.07(2)(b)).

### Cumulative cancer risk approach

Adds the individual excess cancer risks of the cPAHs present in a soil sample and compares the total value to the threshold for acceptable cumulative excess cancer risk of 1-in-100,000 (i.e.,  $1 \times 10^{-5}$ ).

Using this approach, the RCL is not exceeded unless there is a cumulative cancer risk exceedance using the cumulative excess cancer risk of  $1 \times 10^{-5}$  (Wis. Admin. Code § NR 720.12(1)(b)). The cumulative cancer risk may be calculated using the cPAH Cumulative Cancer Risk (CCR) Calculator in the RCL spreadsheet. See also Section 8.2.2.

### 6.1 Methodology - Default DC-RCLs

The default industrial and non-industrial DC-RCLs were determined in accordance with Wis. Admin. Code § 720.12 and may be used for site decision-making, unless a site-specific RCL or risk assessment is approved by the DNR. The DC-RCL category is based on the current land use and the zoning of the property (i.e., land use classification) when a remedial action is selected. Consideration of future land use and uses of nearby properties is recommended when determining which DC-RCL category to apply.

When using the RSL Calculator, select the **Resident** scenario to establish non-industrial DC-RCLs and select the **Composite Worker** scenario for industrial DC-RCLs. See Appendix A for further instructions.

### References for DC-RCLs

- *Guidance: Contaminated Soil Quick Reference Table* (RR-106)
- *Guidance: Soil RCL Spreadsheet* (RR-0151)

*Table 1. Exposure scenarios used to calculate industrial and non-industrial DC-RCLs from the RSL Calculator*

DC-RCL Type	Exposure Scenario	Exposure Duration (yr)	Exposure Frequency (day/yr)	Exposure Time (hr/day)
Non-Industrial	Residential	26	350	24
Industrial	Composite Worker	25	250	8
Site-Specific (example)	Recreational	24	175	4

The RSL User's Guide (<https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide>) defines the exposure scenarios as follows:

A **Residential** receptor "spends most, if not all, of the day at home. The activities for this receptor involve typical home making chores (cooking, cleaning and laundering) as well as outdoor activities. The resident is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with soil, inhalation of volatiles and fugitive dust. Adults and children exhibit different ingestion rates for soil. For example, the child resident is assumed to ingest 200 mg per day while the adult ingests 100 mg per day. Note that the soil ingestion rates are intended to also represent ingestion of indoor dust."

The **Composite Worker** receptor is a "full-time employee working on-site and spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, landscaping) typically involve on-site exposure to surface soils. The composite worker is expected to have an elevated soil ingestion rate (100 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with soil, inhalation of volatiles and fugitive dust. The composite worker combines the most protective exposure assumptions of the outdoor and indoor workers."

The **Recreational** receptor "spends time outside involved in recreational activities. The recreator is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with contaminants in soil, and inhalation of volatiles and fugitive dust."

The DNR recommends adoption of all default exposure parameters used in the RSL Calculator. The default exposure parameters used in the RSL Calculator are regularly reviewed and updated based on the most current data.

## 6.2 Methodology - Site-Specific DC-RCLs

Responsible parties may determine a site-specific DC-RCL using alternative exposure assumptions specifically approved by the DNR in writing (Wis. Admin. Code § NR 720.12(2)). Any request for a site-specific DC-RCL should include documentation to justify modifications to exposure parameters or soil parameters.

For example, a responsible party may want to establish a site-specific DC-RCL at a park used for recreational purposes, where soil contamination is not contributing to groundwater contamination. Consult with DNR staff prior to utilizing this option at your site.

Use the *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request* form (4400-237) to request DNR approval of a site-specific DC-RCL or to use an alternate method to establish DC-RCLs. Under Section 3, check the box for **Approval of a Site-Specific Soil Cleanup Standard**.

### 6.3 Methodology - Contaminant-Specific Issues

There are some instances when the standard equations used in the RSL Calculator do not apply, or where adjustments are made for specific chemicals.

- **Arsenic** - the screening levels for ingestion of soil and sediment are calculated using a default relative bioavailability factor (RBA) of 0.6. If site-specific RBA is known from soil bioavailability data, this RBA value can be adjusted.
- **Chromium (VI)** - if chromium (VI) is a suspected site contaminant, the DNR may require the collection of valence-specific data. The screening level calculator assumes a 1:6 ratio of chromium (VI) to chromium (III), which may result in an overestimate or underestimate of the risk from exposure to chromium (VI)-contaminated soils at the site.
- **Lead** - because there is no consensus reference dose (RfD) for lead, U.S. EPA uses the Integrated Exposure-Uptake Biokinetic Model (IEUBK) and the Adult Lead Methodology (ALM) to evaluate lead exposure using blood-lead modeling. These models estimate blood-lead levels from ingestion of lead-contaminated water, soil, and potentially other dietary sources of exposure to lead. More information on the IEUBK and ALM and how they are applied at sites can be found at <https://www.epa.gov/superfund/lead-superfund-sites>.
- **PCBs and Aroclors** - the relative risk associated with PCBs/Aroclors is determined by the number of congeners with more than four chlorines. Toxicity information for Aroclors is determined by a tiered ranking of risk based on the number of congeners with more than four chlorines. For soil, Aroclor 1016 is in the lowest risk tier, and all other Aroclors are in the highest risk tier. When comparing site soil data to RCLs, the Aroclor data are summed to determine the total PCB value when more than one Aroclor is detected. The total PCB value is compared to the Total PCB RCL (CAS# 1336-36-3) found in the RCL spreadsheet. If only one Aroclor is detected, it is appropriate to compare the soil data to the Aroclor-specific RCL.
- **PFAS** - the *Soil RCL Spreadsheet* (RR-0151) includes DC-RCLs for some PFAS. In some instances, the U.S. EPA RfDs are still proposed values under review by U.S. EPA. PFAS DC-RCLs will be updated as U.S. EPA reviews PFAS toxicological information and makes determinations about appropriate RfD values for each PFAS.

## 7 Other Pathways of Concern

Other pathways of concern at a site or facility may present the potential for exposure and threaten human and ecosystem health, and in some cases present a risk of explosion or contribution to a vapor intrusion pathway. These pathways can include contaminant migration, runoff from the site or facility to surface water, contaminated soil, and bioaccumulation and uptake through the food chain.

A risk assessment may be appropriate at complex sites to establish site-specific cleanup levels for soil and other media. Risk assessments may be appropriate when meeting RCLs is not practicable, or if more stringent standards may be needed at a site to be protective. Risk assessments may be considered only with approval from the DNR (Wis. Admin. Code § NR 722.11(1)).

Contact the DNR project manager to discuss using a risk assessment approach prior to proceeding. Use the *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request* form (4400-237) to request DNR approval of use of a risk assessment. Under Section 3, check the box for **Approval of a Site-Specific Soil Cleanup Standard** (Wis. Admin. Code § NR 722.11(1)).

### Resources for Evaluating Risk for Other Pathways:

- *Ecological Benchmark Tool for Chemicals* (<https://rais.ornl.gov/index.html>). Includes ecological screening levels for soil and other media for individual chemicals.
- U.S. EPA's *Ecological Risk Assessment* (<https://www.epa.gov/risk/ecological-risk-assessment>). A resource to assess ecological risk.
- DNR's *Vapor Intrusion Guidance* (RR-800). Evaluates the vapor intrusion pathway.

## 8 Using RCLs and Background Threshold Values to Inform Site Decisions

Concentrations of contaminants in soil are reviewed throughout the investigation and cleanup process, starting with the hazardous substance discharge notification to the DNR. During a site investigation, concentrations are compared to RCLs and background threshold values (BTVs) to determine the nature, degree and extent of contamination, and to assess the need for remedial actions. Responsible parties shall select and implement a remedial action to address soil contamination when the information collected during the investigation indicates that a remedial action to address soil contamination is necessary to comply with soil cleanup standards (Wis. Admin. Code § NR 720.05(1)).

### 8.1 Land Use Classification and Area of RCL Application

Determining the land use classification is the first step when establishing RCLs (see Section 3.3). After determining the appropriate land use classification(s), concentrations of contaminants in soil are compared to the applicable industrial or non-industrial DC-RCLs, GW-RCLs and BTVs (if applicable).

### 8.2 Using the RCL Spreadsheet to Evaluate Site Soil Data

The *Soil RCL Spreadsheet* (RR-0151) contains RCLs for the most common chemicals and allows users to evaluate site analytical data for soil samples. The RCL Spreadsheet includes the following worksheets:

- **Overview** - provides explanations of the worksheets and instruction on their use
- **Compiled RCLs** - a summary table including all DC-RCLs, GW-RCLs and BTVs
- **Non-Industrial DC-RCLs** - DC-RCLs for non-industrial land uses
- **Industrial DC-RCLs** - DC-RCLs for industrial land uses
- **Non-Ind\_cPAH CCR Calculator and Ind\_cPAH CCR Calculator** - allows the input of site soil data to calculate the cumulative cancer risk (CCR) from cPAHs
- **GW-RCLs** - groundwater pathway RCLs

The *RCL Spreadsheet* is a tool that may be used to compare concentrations of common contaminants in soil to default RCLs. RCL values in the RCL Spreadsheet were calculated using the RSL Calculator, in accordance with the standards for establishing RCLs protective of human health and groundwater quality (Wis. Admin. Code §§ NR 720.10 and NR 720.12). The RCL Spreadsheet also includes surficial soil BTVs for 16 inorganics (see Section 8.5). The RCL Spreadsheet is updated when the U.S. EPA conducts semiannual updates to its RSL Calculator. An example table that meets code requirements for reporting analytical results is included in Appendix B (Wis. Admin. Code § NR 716.15(4)(e)).

Contaminant RCLs are listed alphabetically but can be sorted and selected based on contaminant type (e.g., inorganics, PCBs, VOCs). For less common contaminants, use the RSL Calculator to establish DC-RCLs or contact the DNR project manager.

#### 8.2.1 Soil Direct Contact Evaluation

The non-industrial and industrial DC-RCL worksheets are used to evaluate contaminants with the potential for human health risk from direct contact with contaminated soil; laboratory results for samples collected from the direct contact interval (usually 0 to 4 ft bgs, see Section 3.4) are compared to the DC-RCLs and BTVs.

**Tips:** When entering site soil data, concentrations are entered in the **Input Site Data** column, in the row that contains the RCL for the contaminant.

- Results below laboratory detection limits are entered as **0** if the laboratory's detection limit is below the respective RCL. If the laboratory's detection limit is above the RCL, **enter the limit of detection.**
- J-flagged results (i.e., an estimated concentration between the limit of detection and the limit of quantitation) are entered as the **estimated concentration.**
- Contact the DNR project manager for assistance when entering data that may be problematic due to detection limits, sample dilutions, matrix interference or other issues.

As data are entered in the **Input Site Data** column, automatic evaluations are completed to populate the spreadsheet. An **E** flag (column J) indicates an individual **DC-RCL** was exceeded. To calculate risk from multiple contaminants, the spreadsheet first calculates the individual cancer risk for each carcinogenic contaminant and the individual hazard quotient for each noncancer contaminant. The hazard quotient (HQ) is automatically populated in column K and the cancer risk (CR) is auto populated in column L. Then the individual HQs are summed to calculate the hazard index (HI) and the individual cancer risks are summed to calculate the cumulative cancer risk (CCR). The HI is compared to the HI criteria of 1, and the CCR is compared to the CCR criteria of  $1 \times 10^{-5}$  (Wis. Admin. Code § NR 720.12(1)(b)). If either the HI or CCR is greater than the criteria established in Wis. Admin. Code § NR 720.12(1)(b), then there is a cumulative exceedance, even if an individual **E** flag is absent. The HI and CCR values are displayed at the top of the spreadsheet above the individual HQ and CR columns, and exceedances of cumulative risk criteria are indicated with red font color.

### 8.2.2 *cPAH Cumulative Cancer Risk Evaluation*

When direct contact with soil contaminated by PAHs is the primary pathway of concern, the use of a cumulative assessment is considered an alternate approach for determining standards exceedances (Wis. Admin. Code § NR 720.07(2)(b)). For cPAHs, an RCL exceedance is determined based on a cumulative cancer risk evaluation, not based on individual exceedances. The cumulative cancer risk for cPAHs can be calculated using the **Non-Ind\_cPAH CCR Calculator** and **Ind\_cPAH CCR Calculator** worksheets in the RCL spreadsheet.

Although many individual PAHs may be present as components of complex mixtures, typical soil-PAH lab analyses report the concentrations for 18 PAHs. Some of the PAHs do not have RSLs (acenaphthalene, benzo[*g,h,i*]perylene, and phenanthrene). Cumulative assessment using the CCR Calculators in the RCL spreadsheet includes the following seven cPAHs that have estimated risk levels assigned using the Relative Potency Factor (RPF) approach (<https://www.epa.gov/sites/default/files/2015-11/documents/pah-rpfs.pdf>) that compares toxicity relative to that of benzo[*a*]pyrene:

- Benzo[*a*]pyrene
- Benz[*a*]anthracene
- Benzo[*b*]fluoranthene
- Benzo[*k*]fluoranthene
- Chrysene
- Dibenz[*a,h*]anthracene
- Indeno[1,2,3-*cd*]pyrene

Naphthalene and 1-methylnaphthalene are also cPAHs included in the 18 PAHs that are commonly reported in a standard PAH analysis; however, their cancer endpoint toxicological factors are derived independent of benzo[a]pyrene. These compounds will continue to be assessed on both an individual and cumulative basis.

When using the **Non-Ind\_cPAH CCR Calculator** and **Ind\_cPAH CCR Calculator** worksheets, enter site soil data in the **Input Site Data** column. Similar to the **Non-Industrial DC-RCLs** and the **Industrial DC-RCLs** worksheets, the spreadsheet will calculate the HQ and the CR for each individual PAH. The HQs and CRs are then summed to determine the HI and the CCR. These values are then compared to the cumulative risk criteria of a HI threshold of 1 and a CCR threshold of  $1 \times 10^{-5}$ . For CCR, only seven cPAHs in the above list are summed. If the CCR value is below the  $1 \times 10^{-5}$  CCR threshold, the DC-RCL is not exceeded for cPAHs, even though there may be individual cPAH RCL exceedances for the seven cPAHs included in the cumulative calculation.

### **8.2.3 Evaluation of Direct Contact with Lead-Contaminated Soil at Residential Properties**

The U.S. EPA updated its guidance on lead in residential soil in 2024 and 2025; it lowered the residential RSL from 400 mg/kg to 200 mg/kg. The DNR adopted U.S. EPA's direct contact RSLs as DC-RCLs, including the updated lead screening level (Wis. Admin. Code §§ NR 720.07(2)(b), 720.12(2)). The DNR applies the 200 mg/kg DC-RCL at properties with non-industrial land use.

### **8.2.4 Evaluation of Direct Contact with PFAS-Contaminated Soil**

Risk from direct contact with PFAS-contaminated soil is assessed on both an individual and cumulative basis when multiple PFAS compounds are present. The RCL Spreadsheet contains DC-RCLs for 13 individual PFAS compounds. Most of the DC-RCLs are for terminal PFAS (e.g., PFOA and PFOS) and not for precursor PFAS compounds. It is recommended that concentrations of PFAS precursors are considered when evaluating the direct contact risk due to their potential to transform to terminal PFAS over time. Additional DC-RCLs for other PFAS compounds and updates to existing DC-RCLs are anticipated as toxicological research on PFAS continues.

The DC-RCL for perfluorooctanoic acid (PFOA) is currently 0.0185 µg/kg. The PFOA DC-RCL may not be practicable to achieve because it is close to the method detection limits for the recommend analytical method (U.S. EPA Method 1633) and is within the range of anthropogenic ambient concentrations detected in several state and nationwide PFAS datasets. Responsible parties may propose using an alternative soil screening level to rule out the need for additional action when PFOA is the primary PFAS detected in soil and there are no known drinking water exposures to PFAS. DNR recommends you discuss the use of a site-specific soil screening level with the DNR project manager for these situations.

PFAS contamination is almost always comprised of mixtures of PFAS compounds. Current research on human health risk from PFAS is focused on several potential methods to evaluate cumulative health risk from PFAS mixtures, including the hazard index or cumulative cancer risk calculations, use of total PFAS concentrations, relative potency evaluations, and other potential approaches.

### 8.2.5 Soil Groundwater Pathway Evaluation

The GW-RCL worksheet contains RCLs for chemicals with public health groundwater quality standards under Wis. Admin. Code ch. NR 140. All soil data are compared to the GW-RCLs, whether they were collected near the water table or in the direct contact interval. With few exceptions, GW-RCL values are less than the DC-RCL values.

For data entries into the worksheets, individual soil contaminant concentrations that exceed GW-RCLs will be flagged. Soil data exceeding GW-RCLs often indicates a need to further evaluate the soil to groundwater pathway and potentially initiate groundwater investigation at a site or facility. A groundwater investigation is also recommended when the GW-RCL is lower than the limit of detection for the soil contaminant.

### 8.3 Using Other Methods to Evaluate Site Soil Data

Responsible parties may summarize data and provide comparisons to RCLs, site-specific RCLs (SS-RCLs) and BTVs using alternative formats. Tabulated soil data is required in Wis. Admin. Code § NR 716.15(4)(e). Tables must use the same unit of measurements as the applicable environmental standards (RCLs) and must indicate which results equal or exceed environmental standards. DNR also recommends including the cumulative cancer risk and hazard index for each sample. An example soil results table is provided in Appendix B.

Wis. Admin. Code § NR 716.13(4) specifies that all soil samples obtained during the field investigation shall be discrete, not composite, samples, unless DNR approves composite sampling in advance for a site-specific situation. One type of compositing that may be considered at a site is Incremental Sampling Methodology (ISM). The Interstate Technical and Regulatory Council (ITRC) maintains an ISM guidance document on its website (<https://ism-2.itrcweb.org/>).

The DNR recommends submittal of a detailed work plan for review and approval if ISM is proposed at a site or facility because this method includes rigorous sampling, subsampling and statistical data evaluation procedures. The number, size, and layout of decision units and the specific number of soil increments to be collected will be site-specific and will depend on the contaminants present and the data quality objectives for the site.

Consult with the DNR prior to utilizing ISM (Wis. Admin. Code § NR 716.13(4)). Use the *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request* form (4400-237) to request DNR approval of ISM. Under Section 3, check the box for **Approval of a Site-Specific Soil Cleanup Standard**.

### 8.4 Soil Averaging

Averaging of soil contaminant data requires prior DNR approval (Wis. Admin. Code § NR 720.07(2)(b)). Statistical averaging may be applied at a site or facility to determine compliance with applicable DC-RCLs; however, most sites lack a sufficient representative dataset to utilize statistical averaging. Averaging concentrations is not appropriate as the sole method for addressing sites with areas of significant soil contamination. Averaging of soil concentrations may be appropriate where the contaminant is widespread, relatively consistent in concentrations and at levels close to the applicable RCL for that compound. See guidance document *Compliance Averaging of Soil Contaminant Concentration Data under Ch. NR 720, Wis. Admin. Code (RR-991)* for more information.

Consult with the DNR prior to utilizing soil averaging (Wis. Admin. Code § NR 720.07(2)(b)). Use the *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request* form (4400-237) to request DNR approval of soil averaging. Under Section 3, check the box for **Approval of a Site-Specific Soil Cleanup Standard**.

## 8.5 Background Soil Concentrations

Wis. Admin. Code § NR 700.03(2) defines background soil quality as:

- a. Soil quality that is attributable to the parent material from which the soil was derived and the natural processes which produce soil, or from contamination attributable to atmospheric deposition including but not limited to the following constituents: lead, polynuclear aromatic hydrocarbons or polychlorinated biphenyls, but not attributable to hazardous substance discharges or the discharge of pollutants, as that phrase is defined in Wis. Stat. § 283.01; and
- b. Soil quality that is found at or within reasonable proximity to the site or facility, at a depth comparable to that of the area to be remediated, in the same soil layer and in an area unaffected by hazardous substance discharges or the discharge of pollutants.

The DNR does not require responsible parties to reduce contaminant concentrations at a site or facility to concentrations below background levels. When a background concentration of a substance is greater than the RCL, it may be used as the soil cleanup standard.

The background threshold value (BTV) represents the upper range of background concentrations in Wisconsin. The DNR used 664 surficial soil samples (0 to 0.5 ft depth) collected statewide in 2006 and 2007 to establish surficial soil BTVs for 16 inorganics ([https://pubs.usgs.gov/sir/2011/5202/pdf/sir2011-5202\\_022412.pdf](https://pubs.usgs.gov/sir/2011/5202/pdf/sir2011-5202_022412.pdf)). The BTVs are the non-outlier maximum inorganic concentrations as shown as "Maximum detected value" in Table 1-2 of the report. The BTVs for the 16 inorganics are listed on the RCL Spreadsheet and included on the *RCL Quick Reference Table - Contaminated Soil* (RR-106).

For substances without an established BTV, the background concentration must be determined on a site-specific basis using a DNR-approved and appropriate method (Wis. Admin. Code § NR 720.07(3)). The location or locations to select for background soil sampling should be as similar as possible to the hazardous substance discharge site but without the presence of discharged contaminant. The RR Program document *Guidance for Determining Soil Contaminant Background Levels at Remediation Sites* (RR-721) contains more information on deriving site-specific BTVs. The DNR recommends discussing the proposed approach with the DNR project manager in advance to ensure that the methodology for determining the BTVs can be approved by the DNR.

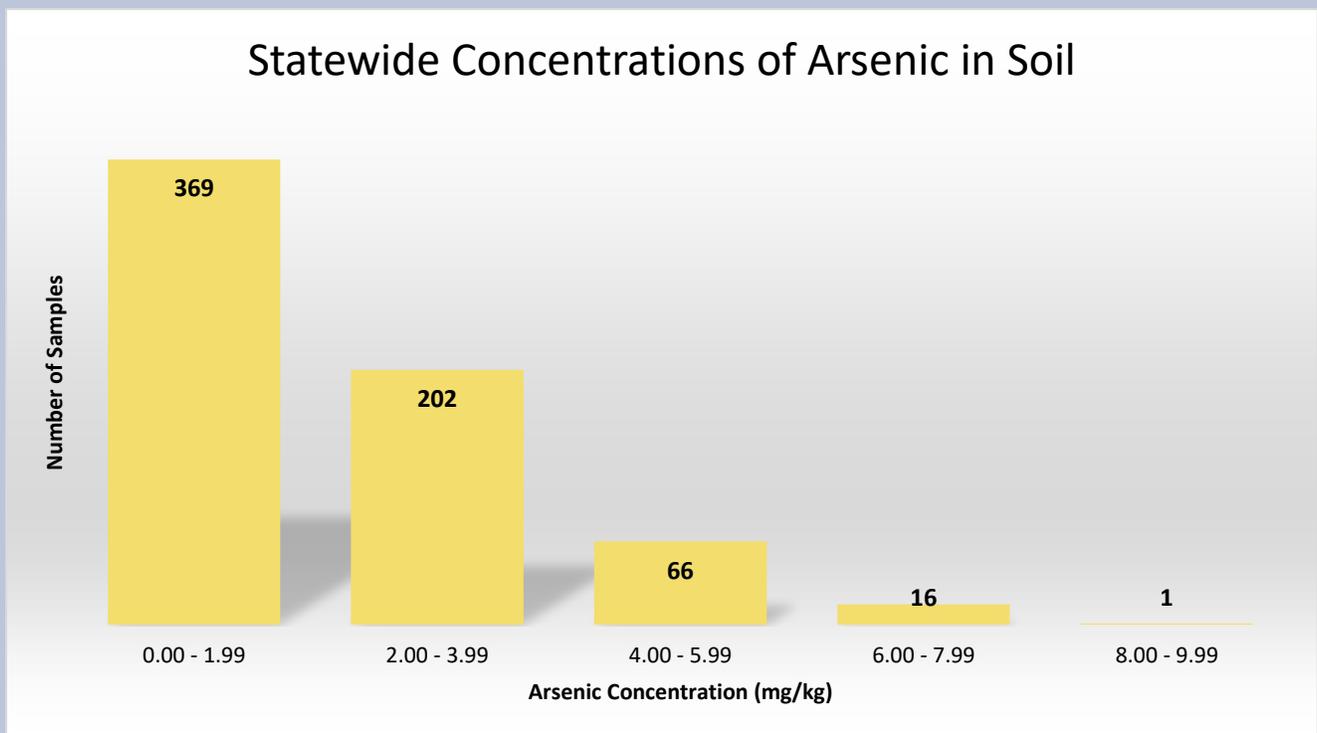
Consult with the DNR prior to utilizing a background concentration (Wis. Admin. Code § NR 720.07(3)). Use the *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request* form (4400-237) to request DNR approval of a method for establishing the background concentration. Under Section 3, check the box for **Approval of a Site-Specific Soil Cleanup Standard**.

**Figure 2. Histogram of arsenic concentrations in Wisconsin**

The histogram below depicts the statewide range of concentrations of arsenic in soil (note: outliers in the dataset were removed). An explanation on the statewide BTV for arsenic is provided in *Wisconsin Statewide Soil-Arsenic Background Threshold Value (RR-940)*.

Concentrations below the BTV are considered within the range of background, and it is difficult to determine if the concentration is indicative of background conditions or from a discharge of a hazardous substance. Concentrations greater than the BTV are assumed to be indicative of a discharge to the environment. For example, the DNR has established a statewide BTV for arsenic of 8.3 mg/kg.

- An arsenic concentration of 5.2 mg/kg is less than the BTV and could be attributed to naturally occurring background or a discharge of a hazardous substance. DNR would not require cleanup of soil at concentrations below background.
- An arsenic concentration of 11.7 mg/kg is greater than the BTV and could be attributed to discharge of a hazardous substance. DNR would require cleanup of soil concentrations above background, unless additional evaluation supports a locally elevated arsenic background concentration.



## 9 Procedures for Establishing Soil Performance Standards

### 9.1 General Requirements

A soil performance standard may be a remedial action (such as a cap or cover) designed to limit or prevent exposure to soil contamination, reduce soil contaminant concentrations, or decrease the risk of soil contamination migrating to groundwater. Existing site conditions (e.g., low-permeability soil) may also be considered a performance standard. One or more performance standards may be used at a site.

A soil performance standard requires monitoring and maintenance and will require a continuing obligation be imposed on the property under Wis. Stat. § 292.12(2) and Wis. Admin. Code §§ NR 708.17(2), NR 722.15(2)(e) or ch. NR 726.

#### Combining Performance Standards with RCLs

Soil performance standards and RCLs may be used in combination. For example, RCLs may be established for part of a site, and performance standards used in other areas of the site. RCLs may also be used to determine where a performance standard is needed.

### 9.2 Protection of Groundwater

The following performance standards may be considered to address the soil to groundwater pathway:

- **Placement of a permanent engineering control** to limit infiltration and minimize the leaching of soil contaminants to groundwater. The engineering control must be maintained until the threat to groundwater no longer exists (Wis. Admin. Code §§ NR 720.08(2)(a) and NR 726.15(2)(d)). Cover and cap design and maintenance are discussed in greater detail in *Guidance for Cover Systems for Soil Performance Standard Remedies*, RR-709).
- **Use of natural attenuation** may be used as a soil performance standard at a site or facility if naturally occurring processes are limiting migration and reducing the mass and concentration of groundwater contaminants, and groundwater contaminant concentrations will be reduced below the ES within a reasonable period of time.

**Tip:** Even when groundwater contamination is not present, evaluate site conditions to determine if a future threat to groundwater exists. This evaluation could include the age of contaminant release, contaminant characteristics, geological setting, depth to groundwater, and the proximity of the monitoring wells to the source of contamination.

### 9.3 Protection from Direct Contact Exposure to Contaminated Soil

Placement of a permanent engineering control that is maintained until the threat of exposure from direct contact no longer exists (e.g., when direct contact RCLs are met) may be considered to address the direct contact pathway. Consider using barriers of compacted clay, geomembranes, paved roadways, parking lots, and building foundations. Permeable barriers may be considered if the contaminants are unlikely to leach from the soil (e.g., PCBs). Permeable barrier design and maintenance is discussed in greater detail in *Guidance for Cover Systems for Soil Performance Standard Remedies* (RR-709).

## 10 Case Closure, Continuing Obligations, and Modifications to Continuing Obligations

Wis. Admin. Code chs. NR 700 - 799 specify the minimum requirements and conditions that must be met before the DNR may grant case closure.

When submitting soil data tables as part of a case closure request (Form 4400-202) the DNR recommends including tables that include all soil analytical results, collection dates, sample depths, soil types and water table elevation. The DNR also recommends including a table that summarizes the analytical results of only the residual soil contamination at the time of closure. This table should include only the soil sample locations that exceed an RCL and indicate if the sample was collected above or below the observed low water table (unsaturated versus saturated). The DNR recommends indicating the cumulative hazard index and cumulative cancer risk (CCR) exceedances in the soil data tables.

For sites or facilities where soil excavation or active soil remediation occurred, include a table of soil analytical results with collection dates identified. Soil analytical data tables shall clearly indicate depth of sample, soil type and whether the sample represents pre-remedial or post-remedial conditions. (Wis. Admin. Code § NR 726.09(2)(d)). At sites or facilities where soil excavation occurred, the soil analytical data tables shall indicate whether the soil data point represents soil that was removed or soil that remains in place (Wis. Admin. Code § NR 726.09(2)(d)). Also include a map that shows the locations of all soil samples collected.

At sites or facilities where soil contamination exceeds RCLs at the time that case closure is requested a table of the analytical results is required for the DNR database listing requirement (Wis. Admin. Code § NR 726.11(6)(a)). Include the most recent samples for all contaminants found in pre-remedial sampling, with sample collection dates identified. The DNR database listing requirement also includes several figures depicting the extent of contamination when soil contamination exceeds the RCLs at the time of closure (Wis. Admin. Code § NR 726.11(5)(c)). This includes the following figures:

- A figure that shows the location where all soil samples were collected and identifies, with a single contour, the horizontal extent of each area of contiguous residual soil contamination that exceeds RCLs within the contaminated site boundaries
- A geological cross section showing the vertical extent of residual soil contamination that exceeds RCLs, if one was required as a part of the site investigation report. One geological cross section may be submitted to show the vertical extent of both soil and groundwater contamination, if there is also groundwater contamination on the site that exceeds groundwater standards

If contaminated soil remains at a site or facility, continuing obligations (COs) may be imposed to prevent exposure to contamination and migration to groundwater after response actions are taken (Wis. Stat. § 292.12(2)). Soil-related conditions that may result in a CO at the time of interim action, remedial action or case closure are further described below. Additional information about COs applied as part of a case closure determination can be found in Wis. Admin. Code chs. NR 726 and NR 727, and the document *Guidance on the Case Closure Process and Continuing Obligations: Wis. Admin. Code chs. NR 725 to 727* (RR-606).

### 10.1 Residual Soil Contamination

At the time of interim action, remedial action or case closure, if site soil contaminant concentrations exceed either GW-RCLs, DC-RCLs, or site-specific RCLs, the **Residual Soil Contamination CO** may be

imposed. This CO requires proper management of contaminated soil if it is excavated or removed from the site in the future (Wis. Admin. Code § NR 726.15(2)(b)). Requirements for sampling, proper handling, management, and disposal apply to soil, sediment, or other solids excavated from an area with residual contamination.

## 10.2 Use of a Cap or Cover as a Performance Standard

If a cap or cover is used to prevent direct contact with contaminated soil or used as an impermeable barrier to prevent groundwater impacts, the **Cover or Engineering Controls for Soil CO** may be imposed. This CO includes requirements for a site-specific cap maintenance plan and notification to the DNR prior to disturbing or making any changes to the cap or cover (Wis. Admin. Code §§ NR 724.13, NR 726.15(2)(d)-(e), NR 727.05, and NR 727.07).

## 10.3 Industrial Soil Standards Applied

When contamination concentrations in soil meet or exceed non-industrial DC-RCLs but are less than industrial DC-RCLs, the **Industrial Soil Standards Applied CO** may be imposed. This CO limits the property to industrial uses, and the DNR must be notified of the intent to change the land use to non-industrial (Wis. Admin. Code §§ NR 726.15(2)(g) and NR 727.07(3)). Additional investigation and remedial action may be needed to meet the applicable DC-RCLs for the anticipated change in land use. (Wis. Admin. Code § NR 727.07)

## 10.4 Site-Specific Condition Applied

If site-specific information has been used to derive a SS-RCL for the groundwater pathway, or if there is a site-specific land use restriction (e.g., recreational, green space, etc.) or a SS-RCL has been applied based on land use, the "Site-Specific CO" is applied. The specific requirements associated with this CO will depend on the specific nature of the CO. For example, if a SS-RCL has been applied based on a specific land use, the DNR will require notification of proposed changes in land use that may necessitate a more protective RCL (Wis. Admin. Code §§ NR 726.15(2)(m) and NR 727.07(7)). If a more protective RCL is needed, then additional investigation and remedial action may be needed.

## 10.5 Modifications to Continuing Obligations

After a CO has been imposed, changes may occur at a property that affect the land use classification or the COs that were applied; the DNR refers to these as continuing obligation modifications. DNR notification is required at least 45 days prior to making modifications at a site, such as removing or replacing a cover or changing the land use, and DNR approval of these changes is also required (Wis. Stat. § 292.12(6); Wis. Admin. Code § NR 727.07).

Use the *Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request* form (4400-237) to request DNR approval of a modification to a CO. Under Section 3, check the box for **Approval of a Site-Specific Soil Cleanup Standard**. More information on this process is available in the document *Guidance on Post-Closure Modifications* (RR-982).

## 11 References

- DHS, 2016, Letter from Jeffrey Phillips to Darsi Foss, Response to the Remediation and Redevelopment Program's Request to Reassess the Residual Contaminant Levels for Polycyclic Aromatic Hydrocarbons (PAHs), October 24, 2016 (available upon request).
- DNR, Memorandum of Understanding Between the Wisconsin Department of Agriculture, Trade & Consumer Protection and the Wisconsin Department of Natural Resources (RR-5058). March 2005 (available upon request).
- Interstate Technology Regulatory Council, Incremental Sampling Methodology Update, <https://ism-2.itrcweb.org/>
- Interstate Technology Regulatory Council, Soil Background and Risk Assessment, <https://sbr-1.itrcweb.org/>
- Siemering, Geoffrey S., 2018, Distribution and Variation of 18 Polycyclic Aromatic Hydrocarbons in Surface Soils of Milwaukee County Parks, Milwaukee Wisconsin. UW-Extension report in cooperation with the Wisconsin Department of Natural Resources and the Wisconsin Department of Health Services (available upon request).
- Stensvold, Krista A., 2011, Distribution and Variation of Arsenic in Wisconsin Surface Soils, With Data on Other Trace Elements. U.S. Geological Survey Scientific Investigations Report 2011-5202. [https://pubs.usgs.gov/sir/2011/5202/pdf/sir2011-5202\\_022412.pdf](https://pubs.usgs.gov/sir/2011/5202/pdf/sir2011-5202_022412.pdf)
- U.S. EPA, Regional Screening Levels for Chemical Contaminants at Superfund Sites, <https://www.epa.gov/risk/regional-screening-levels-rsls>
- U.S. EPA, Relative Potency Factors for Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs), <https://www.epa.gov/sites/default/files/2015-11/documents/pah-rpfs.pdf>
- U.S. EPA, OSWER Directive 9200.1-120, Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, Feb. 6, 2014, [https://www.epa.gov/sites/default/files/2015-11/documents/oswer\\_directive\\_9200.1-120\\_exposurefactors\\_corrected2.pdf](https://www.epa.gov/sites/default/files/2015-11/documents/oswer_directive_9200.1-120_exposurefactors_corrected2.pdf)

## Appendix A. U.S. EPA RSL Calculator

### A1 Background and How to Use

The DNR uses the U.S. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites Calculator (RSL Calculator, available at [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl\\_search](https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search)). The RSL Calculator was developed with U.S. Department of Energy's Oak Ridge National Laboratory and is the source of screening levels for all U.S. EPA regions. The RSL Calculator derives risk-based screening levels, calculated using the latest toxicity values, default exposure assumptions, physical and chemical properties, and an in-tool calculator that allows changes to default parameters to reflect site-specific factors. The DNR uses the RSL Calculator to calculate RSLs for direct contact with soil and for the soil to groundwater pathway. These values are converted to RCLs and compiled in the *Soil RCL Spreadsheet* (RR-0151).

The RSL Calculator allows users to calculate RSLs by selecting a specific exposure scenario (e.g., resident, worker, soil to groundwater) and the chemicals of concern. The default values in the calculator are used with a few exceptions detailed in Section 6.2. If site specific RCLs are being calculated, exposure and soil parameter values may be modified to represent site conditions.

The RSL Calculator determines a single contaminant's level of concern (concentration in soil) but does not address cumulative concerns when multiple contaminants are present at a site. The RCL Spreadsheet contains RCLs generated from the RSL web calculator and may be used to enter site soil data to calculate cumulative risk; the calculation assumes simple additivity of the hazard quotients and the cancer risks from the individual chemicals. With the RCL Spreadsheet, the user may determine individual exceedances and cumulative exceedance when there is a potential for direct contact with soil containing multiple contaminants.

The RCL assumes a contaminated area of exposure that is no larger than a 0.5-acres; the DNR does not require modifications to the RCL for larger sites. This is because typical soil sampling tends to follow a directed sampling technique that focuses on areas where contamination is known or suspected. Directed sampling is based on some knowledge or data (e.g., follow-up sampling) such that any bias does not under-represent existing contaminant concentrations. For example, samples sent to the lab are often the samples with the highest field readings from a photoionization detector. Comparison to the calculated RCL informs if remediation is warranted.

The RCL must be less than the ceiling concentration of 10% by weight (or 100,000 mg/kg), or if the contaminant is a volatile substance, no greater than its soil saturation concentration ( $C_{sat}$ ) (Wis. Admin. Code § NR 720.07(1)(b)1).

### A2 Using the RSL Calculator to Develop Groundwater Pathway RCLs

Default and site-specific GW-RCLs are calculated using the RSL Calculator and selecting the **Soil to Groundwater** scenario. The RSLs are based on U.S. EPA's MCLs and other risk-based screening levels, therefore the results in the output from the calculator need additional processing to calculate compliant GW-RCLs.

The RSLs are converted to GW-RCLs by replacing the MCL with the ES as the appropriate target groundwater concentration, and by applying a dilution attenuation factor (DAF) of 2 (the RSL calculator assumes a DAF of 1). See instructions below. Default GW-RCLs are summarized in the *Soil RCL Spreadsheet* (RR-0151).

## A2.1 Calculating Default GW-RCLs

To calculate default soil to groundwater RSLs, select the following options in the RSL Calculator input screen:

<b>Screening Level Type:</b>	Regional Screening Levels (RSLs)
<b>Hazard Quotient:</b>	1
<b>Target Risk:</b>	10 <sup>-6</sup>
<b>Scenario:</b>	Soil to Groundwater
<b>Screening Level Choice:</b>	Defaults
<b>Risk Output:</b>	No
<b>RfD/RfC Choice:</b>	Chronic

Enter specific chemicals, or **Select All Chemicals**, and then click **Retrieve**. If **Select All Chemicals** is entered, you may also download the RSL output table as a Microsoft Excel spreadsheet from the output screen. If only a few chemicals are selected, the RSL Calculator generates an html output. Both output screens include an option for downloading EQUIS and SADA formatted tables.

The output table contains the RSL for each chemical as either an MCL-Based screening level (SL) or a risk-Based SL.

To convert the SLs to GW-RCLs:

1. Identify the columns containing the **MCL-Based SL** and the **Risk-Based SL** by scrolling to the far right of the output table.
2. Calculate the **SL/Water Concentration Ratio** using one of the following methods:
  - a. If the chemical has an **MCL-Based SL** (orange column), divide the **MCL-Based SL** by the **MCL-Based Water Concentration**.
  - b. If the chemical does not have an **MCL-Based SL**, use the **Risk-Based SL** (red column). Identify which **Water Concentration** value to use by noting whether the **Risk-Based SL** is based on cancer risk (ca) or noncancer risk (nc).
    - i. If the **Risk-Based SL** is based on cancer risk, divide the **Risk-Based SL** by the **Water Concentration (Cancer)**.
    - ii. If the **Risk-Based SL** is based on noncancer risk, divide the **Risk-Based SL** by the **Water Concentration (Child)**.
3. Multiply the ratio calculated in the previous step by the ES for the compound to calculate the **ES-Based SL**.
4. Multiply the **ES-Based SL** by a DAF of 2 to obtain the default GW-RCL.

Chemical	D <sub>nc</sub>	D <sub>ca</sub>	B	A	C	A/B or C/D <sub>ca</sub> or C/D <sub>nc</sub>	Ratio x ES	ES-based SL x 2	
	Water Concentration (Child) (mg/L)	Water Concentration (Cancer) (mg/L)	Water Concentration (MCL) (mg/L)	MCL-based SL (mg/kg)	Risk-Based SL (mg/kg)	Ratio MCL-SL/MCL-Conc or RB-SL/RB-Conc (mg/L)	NR 140 ES Conc (mg/L)	NR 720 Default GW-RCL (mg/kg)	
Acetochlor	3.53E-01	-	-	-	2.81E-01 nc	0.796	0.007	0.00557	0.011
Acetone	1.80E+01	-	-	-	3.68E+00 nc	0.204	9	1.84	3.7
Alachlor	1.56E-01	1.06E-03	2.00E-03	1.65E-03	8.73E-04 ca	0.825	0.002	0.00165	0.0033
Aldicarb	1.98E-02	-	3.00E-03	7.48E-04	4.93E-03 nc	0.249	0.01	0.00249	0.005
Aluminum	2.00E+01	-	-	-	3.00E+04 nc	1500	0.2	300	600
Anthracene	1.77E+00	-	-	-	5.81E+01 nc	32.8	30	984.74576	1969
Antimony (metallic)	7.79E-03	-	6.00E-03	2.71E-01	3.52E-01 nc	45.2	0.006	0.271	0.54
Arsenic, Inorganic	5.99E-02	5.17E-05	1.00E-02	2.92E-01	1.51E-03 ca	29.2	0.01	0.292	0.58
Atrazine	5.40E-02	3.02E-04	3.00E-03	1.95E-03	1.96E-04 ca	0.650	0.003	0.00195	0.0039
Barium	3.77E+00	-	2.00E+00	8.24E+01	1.55E+02 nc	41.2	2	82.4	165
Bentazon	5.66E-01	-	-	-	1.24E-01 nc	0.219	0.3	0.06572	0.13
Benzene	3.32E-02	4.55E-04	5.00E-03	2.56E-03	2.33E-04 ca	0.512	0.005	0.00256	0.0051
Benzo[a]pyrene	6.02E-03	2.51E-05	2.00E-04	2.35E-01	2.94E-02 ca	1175	0.0002	0.235	0.47
Benzo[b]fluoranthene	-	2.51E-04	-	-	3.00E-01 ca	1195	0.0002	0.239	0.48

### A2.2 Calculating Site-Specific GW-RCLs

When calculating site-specific GW-RCLs, follow the steps for the RSL Calculator outlined above, with the following exception: select **Site Specific** instead of **Default** when making your **Screening Level Choice**. The **Site Specific** screening level opens an input screen that allows the user to modify many parameters. The DNR recommends making no changes to the exposure parameters. Possible modifications for site-specific parameters include entering a site-specific DAF, entering site hydrogeologic conditions to calculate a site-specific DAF, and entering site-specific soil properties into the calculator’s partitioning equation. The options are shown below.

Calculate a site-specific DAF by entering site-specific hydrogeologic parameters in the input screen shown below.

Dilution Factor for Migration to Groundwater Equations and Parameters

[Dilution Attenuation Factor](#)

<input style="width: 90%;" type="text"/> K (aquifer hydraulic conductivity) m/yr <input style="width: 90%;" type="text"/> L (source length parallel to ground water flow) m <input style="width: 90%; background-color: #0056b3; color: white;" type="text"/> d (mixing zone depth) m - site-specific <input style="width: 90%;" type="text"/> d <sub>s</sub> (aquifer thickness) m - site-specific	<input style="width: 90%; text-align: center;" type="text" value="1"/> DAF (dilution attenuation factor) unitless <input style="width: 90%;" type="text"/> i (hydraulic gradient) m/m <input style="width: 90%; text-align: center;" type="text" value="0.18"/> I (infiltration rate) m/yr
--	--

**NOTES:**

- When DAF is entered or calculated, the values for the blue DAF box in the Migration to Groundwater section below will be populated. If DAF is not entered or calculated, the default value will be used.
- If DAF is known, enter it, or enter your own site-specific values to calculate it.

If the site-specific DAF is known, it may also be entered directly into the following input screen:

Migration to Groundwater Common Parameters	
<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <span style="background-color: #1a4a8e; color: white; padding: 2px 5px;">1</span> DAF (dilution attenuation factor) unitless                 </div> <div style="margin-left: 20px;"> <input checked="" type="radio"/> Method 1 - Partitioning  <input type="radio"/> Method 2 - Mass Limit                 </div>	<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <input style="width: 80%;" type="text" value="1.5"/> <math>\rho_b</math> (dry soil bulk density) kg/L                 </div>
<p><b>NOTES:</b></p> <ol style="list-style-type: none"> <li>If DAF is known, enter it in the <a href="#">Dilution Factor</a> section above. When DAF is entered or calculated in the section above, the value for the blue DAF box in this section will be populated. If DAF is not entered or calculated, the default value will be used.</li> <li>The Partitioning Equation for Migration to Ground Water is used by default. To use the <a href="#">Mass-Limit Equation</a>, select the Method 2 Equation toggle and enter the parameters below.</li> </ol>	

If site-specific soil parameters are known, they may be entered into the following input screen and will be used in the partitioning equation used to calculate soil to groundwater RSLs as shown below.

Partitioning Equation and Parameters	
<p><a href="#">H<sup>+</sup> Determination at Temperature other than 25 degrees Celsius</a></p>	
<p><a href="#">Method 1</a></p>	
<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <input style="width: 80%;" type="text" value="0.002"/> foc (fraction organic carbon in soil) g/g                 </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <input style="width: 80%; background-color: #1a4a8e; color: white;" type="text" value="0.434"/> n (soil porosity) <math>L_{pore}/L_{soil}</math> </div> <div style="border: 1px solid #ccc; padding: 5px;"> <input style="width: 80%;" type="text" value="2.65"/> <math>\rho_s</math> (soil particle density) kg/L                 </div>	<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <input style="width: 80%; background-color: #1a4a8e; color: white;" type="text" value="0.134"/> <math>\theta_a</math> (air-filled soil porosity) <math>L_{air}/L_{soil}</math> </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <input style="width: 80%;" type="text" value="0.3"/> <math>\theta_w</math> (water-filled soil porosity) <math>L_{water}/L_{soil}</math> </div> <div style="border: 1px solid #ccc; padding: 5px;"> <input style="width: 80%;" type="text" value="25"/> <math>T_w</math> (groundwater temperature) °Celsius                 </div>

### A2.3 Other Notes About GW-RCLs

The *Soil RCL Spreadsheet* (RR-0151) only includes GW-RCLs for chemicals that have an ES. If a GW-RCL is needed for a chemical without an ES, U.S. EPA’s MCL-Based SL may be used (if there is no ES and no DHS recommended level). A Risk-Based SL may also be used. Contact the project manager to determine the appropriate GW-RCL.

### A3 Using the RSL Calculator to Derive DC-RCLs

The DNR uses the RSL Calculator to calculate non-industrial and industrial DC-RCLs. When using the RSL Calculator to calculate non-industrial DC-RCLs, select the **Resident** scenario. When calculating industrial DC-RCLs, select the **Composite Worker** scenario. The DNR maintains a list of non-industrial and industrial DC-RCLs in its *Soil RCL Spreadsheet* (RR-0151).

#### A3.1 Deriving Default DC-RCLs

To calculate default soil to groundwater RSLs, select the following options in the RSL Calculator input screen:

<b>Screening Level Type:</b>	Regional Screening Levels (RSLs)
<b>Hazard Quotient:</b>	1
<b>Target Risk:</b>	$10^{-6}$
<b>Scenario:</b>	Resident (for Non-Industrial DC-RCLs) or Composite Worker (for Industrial DC-RCLs)
<b>Media:</b>	Soil
<b>Screening Level Choice:</b>	Site Specific
<b>Risk Output:</b>	No
<b>RfD/RfC Choice:</b>	Chronic

Enter specific chemicals, or **Select All Chemicals**, and then click **Retrieve**.

After clicking **Retrieve**, another input screen appears. Check the top two boxes to substitute the  $C_{sat}$  for the soil inhalation RSL and to substitute the theoretical ceiling limit for the total soil RSL. Do not modify any of the inputs for the **Exposure Assessment Details**. These details represent the default exposure assumptions for each exposure scenario and differ depending on the selection of the **Resident** scenario or **Composite Worker** scenario.

In addition to the **Exposure Assessment Details** screen, there are five other input screens:

- **Ingestion, Dermal, and Inhalation Exposure**
- **Mutagenic Parameters**
- **Particulate Emission Factor Wind Driven**
- **Volatilization Factor and Soil Saturation**
- **Volatilization Factor - Mass Limit**

Do not alter any of the default inputs, except for setting the **Climatic Zone** in the following three screens: **Particulate Emission Factor Wind Driven**, **Volatilization Factor and Soil Saturation**, and **Volatilization Factor - Mass Limit**. The DNR selects **Chicago, IL** as the Climatic Zone for derivation of RCLs.

After selecting the Climatic Zone, scroll to the bottom of the input screens and hit **Retrieve**.

If **Select All Chemicals** is entered, you can also download the RSL output table as a Microsoft Excel spreadsheet from the output screen. If only a few chemicals are selected, the RSL Calculator generates an html output. Both output screens include an option for downloading EQulS and SADA formatted tables.

When viewing the output table, the RSLs are found in the column on the right labeled **Screening Level** and each RSL has an attached qualifier described below.

<b>nc</b>	indicates the RSL is based on noncancer risk
<b>ca</b>	indicates the RSL is based on cancer risk
<b>max</b>	indicates the RSL based on risk exceeds the theoretical ceiling limit of 10+5 mg/kg, equivalent to the chemical representing 10% by weight of the soil. In this case, 100,000 mg/kg is substituted for the RSL. See Section 5.13 in the U.S. EPA RSL User's Guide for more information.
<b>sat</b>	indicates the RSL based on risk exceeds the C <sub>sat</sub> , thus the C <sub>sat</sub> is substituted for the RSL. See Section 5.12 in the U.S. EPA RSL User's Guide for more information.

### A3.2 Developing Site-Specific DC-RCLs

For some sites, it may be appropriate to calculate a site-specific DC-RCL. The example below illustrates the process of deriving site-specific DC-RCLs for a recreational exposure scenario. See Section 6.2 for more information on the process for requesting a site-specific DC-RCL. The DNR must approve any changes to the default exposure parameters used to derive the site-specific RCLs, and supporting documentation is needed to determine land use classification, use of the property, and appropriate exposure scenarios to evaluate (Wis. Admin. Code § NR 720.12(2)).

**Example:** *Developing site-specific DC-RCLs at a county park. The current and anticipated future land use at the park is recreational.*

- 1) Select:
  - **Recreator** scenario
  - **Soil/Sediment** for media
  - Enter specific chemicals or **Select All Chemicals**
- 2) Click **Retrieve**.
- 3) The **Exposure Assessment Details** screen will appear. Check the top two boxes to substitute the C<sub>sat</sub> for the soil inhalation RSL and to substitute the theoretical ceiling limit for the total soil RSL as shown.
- 4) Enter the modified exposure parameters for the site-specific recreational scenario into the **Exposure Assessment Details** input screen.

In this example, the park is in a residential neighborhood and is used frequently by residents of all ages. The assumptions used for this recreational exposure scenario include:

- **Exposure Factor (EF):** 175 days/year, based on 5 site visits per week, over 35 weeks per year, in non-winter conditions
- **Exposure Time (ET):** 4 hrs, based on average time spent outdoors, from the U.S. EPA's Exposure Factor Handbook (2011)
- The other inputs are the default exposure parameters used by the U.S. EPA and are not modified.

- 5) Follow the instructions for each of the input screens below:
- **Ingestion, Dermal, and Inhalation Exposure** - no changes to default inputs
  - **Mutagenic Parameters** - no changes to default inputs
  - **Particulate Emission Factor Wind Driven** - change Climatic Zone to Chicago, IL
  - **Volatilization Factor and Soil Saturation** - change Climatic Zone to Chicago, IL
  - **Volatilization Factor - Mass Limit** - change Climatic Zone to Chicago, IL
- 6) Scroll to the bottom of the input screens and hit **Retrieve**. If **Select All Chemicals** is entered, you may also download the RSL output table as a Microsoft Excel spreadsheet from the output screen. If only a few chemicals are selected, the RSL Calculator generates an html output. Both output screens include an option for downloading EQulS and SADA formatted tables.

When viewing the output table, the RSLs are found in the column on the right labeled Screening Level and each RSL has an attached qualifier described below.

<b>nc</b>	indicates the RSL is based on noncancer risk
<b>ca</b>	indicates the RSL is based on cancer risk
<b>max</b>	indicates the RSL based on risk exceeds the theoretical ceiling limit of $10^5$ mg/kg, equivalent to the chemical representing 10% by weight of the soil. In this case, 100,000 mg/kg is substituted for the RSL. See Section 5.13 in the U.S. EPA RSL User's Guide for more information.
<b>sat</b>	indicates the RSL based on risk exceeds the $C_{sat}$ , thus the $C_{sat}$ is substituted for the RSL. See Section 5.12 in the U.S. EPA RSL User's Guide for more information.

**Appendix B. Soil Sample Results Table**

The image of a soil sample results table below is an example of how to properly format site soil data in comparison to DC-RCLs, GW-RCLs, and BTVs, and how to display both individual and cumulative risk assessment.

Refer to *Guidance: Soil Residual Contaminant Level (RCL) Spreadsheet (RR-0151)* for current RCL values.

					Location:										
					SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-6	SS-7	SS-8	SS-9	
					Sample Name:	SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-6 Dup	SS-7	SS-8	SS-9
					Sample Date:	7/1/2019	7/1/2019	7/1/2019	7/1/2019	7/1/2019	7/1/2019	7/1/2019	7/1/2019	7/1/2019	7/1/2019
					Sample Depth (ft):	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
Analyte	Unit	CAS#	DC-RCL Non-Ind	GW-RCL											
Acenaphthene	mg/kg	83-32-9	3,590		0.008	0.0065	0.0237	0.0364	0.0108	0.0054	0.0062	0.0069	0.0069	0.0037	
Anthracene	mg/kg	120-12-7	17,900	197	0.0207	0.0188	0.0482	0.0283	0.0287	0.0185	0.0205	0.0194	0.0203	0.011	
Benzo(a)anthracene	mg/kg	56-55-3	1.14		0.164	0.172	0.415	0.762	0.212	0.149	0.162	0.165	0.17	0.109	
Benzo(a)pyrene	mg/kg	50-32-8	0.115	0.47	<b>0.194</b>	<b>0.203</b>	<b>0.454</b>	<b>0.898</b>	<b>0.245</b>	<b>0.172</b>	<b>0.194</b>	<b>0.194</b>	<b>0.194</b>	<b>0.133</b>	
Benzo(b)fluoranthene	mg/kg	205-99-2	1.15	0.48	0.301	0.305	<i>0.63</i>	<b>1.290</b>	0.375	0.262	0.292	0.292	0.292	0.202	
Benzo(k)fluoranthene	mg/kg	207-08-9	11.5		0.116	0.125	0.32	0.421	0.15	0.107	0.113	0.116	0.109	0.0757	
Chrysene	mg/kg	218-01-9	115.0	0.14	<i>0.212</i>	<i>0.23</i>	<i>0.39</i>	<i>0.714</i>	<i>0.286</i>	<i>0.19</i>	<i>0.209</i>	<i>0.217</i>	<i>0.216</i>	0.141	
Dibenz(a,h)anthracene	mg/kg	53-70-3	0.115		<0.00056	<0.00055	<0.00054	0.373	<0.00052	0.0352	<0.00054	0.0407	0.04	<0.00051	
Fluoranthene	mg/kg	206-44-0	2,390	89	0.393	0.416	0.836	0.784	0.52	0.34	0.373	0.377	0.381	0.248	
Fluorene	mg/kg	86-73-7	2,390	15	0.009	0.0073	0.025	0.076	0.0136	0.006	0.0065	0.0081	0.0083	0.0046	
Indeno(1,2,3-cd)pyrene	mg/kg	193-39-5	1.15		0.127	0.125	0.322	<b>1.33</b>	0.156	0.115	0.13	0.133	0.128	0.0907	
1-Methylnaphthalene	mg/kg	90-12-0	0.265		0.0019 J	0.0018 J	0.0037	0.0057	0.003	0.002 J	0.0023 J	0.0022 J	0.0021 J	0.0012 J	
2-Methylnaphthalene	mg/kg	91-57-6	239		0.0021 J	0.0018 J	0.0037	0.0056	0.0031	0.0022 J	0.0025	0.0025	0.0023	0.0013 J	
Naphthalene	mg/kg	91-20-3	2.4	0.66	0.0023 J	0.0017 J	0.0028 J	0.0067	0.0031 J	0.002 J	0.0024 J	0.0026 J	0.0021 J	0.0012 J	
Pyrene	mg/kg	129-00-0	1,790	55	0.332	0.348	0.712	0.322	0.423	0.29	0.313	0.327	0.325	0.209	
<b>GW-RCL Exceedance Count:</b>					1	1	2	3	1	1	1	1	1	0	
<b>DC-RCL Exceedance Count:</b>					1	1	1	3	1	1	1	1	1	1	
<b>DC Hazard Index (HI):</b>					0.018	0.019	0.040	0.073	0.026	0.018	0.020	0.020	0.019	0.012	
<b>DC Cumulative Cancer Risk (CCR):</b>					2.2E-06	2.3E-06	5.2E-06	<b>1.4E-05</b>	2.8E-06	2.3E-06	2.2E-06	2.6E-06	2.6E-06	1.5E-06	

**Notes:**

**Red** font indicates DC-RCL exceedance

*Italic* font indicates GW-RCL exceedance

< = below limit of detection

J = Estimated value. Analyte concentration between limit of detection and limit of quantitation

***Appendix C. Dioxin/Furan Toxicity Equivalency Quotient Calculation***

2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD) and dioxin/furan compounds, including polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs), commonly occur as mixtures in environmental media. In 2012, U.S. EPA published an oral non-cancer toxicity value, or reference dose (RfD), for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) in U.S. EPA's Integrated Risk Information System (IRIS). Because RfDs for other dioxin/furan compounds have not been developed yet, their toxicity can be addressed by considering their toxicity relative to TCDD using Toxicity Equivalence Factors (TEFs). TCDD is assigned a TEF of 1, and TEFs for dioxin/furan compounds are a measure of the compound's toxicity relative to TCDD. For each dioxin/furan compound, the dioxin toxicity equivalence (or TCDD TEQ) is the product of the concentration of the dioxin/furan compound in soil and its corresponding TEF; total TEQ for the mixture is the sum of the individual TCDD TEQs for all the detected dioxin/furan compounds. The total TEQ for the mixture, rather than individual dioxin/furan concentrations measured in soil, is used for site evaluation purposes. In other words, the TCDD TEQ concentration is compared to the 2,3,7,8-TCDD RCL to determine if there is an RCL exceedance.

U.S. EPA provides additional information in the fact sheet *Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites* (<https://semspub.epa.gov/work/HQ/174558.pdf>). U.S. EPA also provides a TEQ calculator to calculate dioxin TCDD TEQ from dioxin/furan congener results, taking into consideration non-detect and rejected data. The calculator and other information on dioxin toxicity may be found on the U.S. EPA's webpage *Risk Assessment for Dioxin at Superfund Sites* (<https://www.epa.gov/superfund/risk-assessment-dioxin-superfund-sites#tefsteps>).