

Sec. 22a-133k-3. Remediation Standards for Groundwater

(a) Groundwater Criteria

Unless otherwise specified in the RSRs, all substances in groundwater from a release shall be remediated to comply with the following, as applicable:

(1) Groundwater in a GA Area

Remediation of substances in groundwater in a GA area, including the portion of a groundwater plume migrating from a GB area into a GA area, shall result in the reduction of each substance to a concentration equal to or less than:

(A) The background concentration, except as provided in subsection (d) of this section, concerning groundwater protection criteria;

(B) Surface water protection criteria or background concentration; and

(C) Volatilization criteria.

(2) Groundwater in a GB Area

Except for any portion of a groundwater plume migrating from a GB area into a GA area that is subject to the requirements of subdivision (1) of this subsection, remediation of substances in groundwater in a GB area shall result in the reduction of each substance to a concentration equal to or less than:

(A) (i) The surface water protection criteria and volatilization criteria; or

(ii) The background concentration; and

(B) The groundwater protection criteria, where the existing use of groundwater is for drinking or other purposes, until the use of such groundwater for drinking or other purposes is permanently discontinued.

(3) Groundwater Plume Discharging to a Low-Dilution Surface Water Body

(A) Remediation of substances in groundwater shall result in the reduction of each substance to a concentration equal to or less than the criteria set forth in subparagraph (B) of this subdivision where such plume discharges to:

(i) A wetland;

(ii) A tidal flat;

(iii) An intermittent watercourse; or

(iv) A location where the areal extent of such groundwater plume occupies more than one half of one percent, or other percentage approved in writing by the commissioner, of the upstream drainage basin of the surface water body to which such plume discharges. The percentage of the upstream drainage basin shall be measured from the intersection of the surface water body with such groundwater plume.

(B) Each substance in groundwater specified in subparagraph (A) of this subsection shall be remediated to a concentration that is either:

(i) Equal to or less than the applicable water quality criteria or, if there are no such criteria, to criteria approved by the commissioner in accordance with subsection (i)(2) of this section; or

(ii) Equal to or less than the alternative surface water protection criteria calculated by an LEP in accordance with subsection (b)(2) of this section or approved by the commissioner in accordance with subsection (b)(3) of this section.

(b) Alternative Surface Water Protection Criteria

With respect to substances in groundwater for which surface water protection criteria are

specified in Appendix D of the RSRs or approved by the commissioner pursuant to subsection (i)(2) of this section, alternative surface water protection criteria may be calculated by an LEP or approved in writing by the commissioner, pursuant to this subsection. For each substance, only one subdivision of this subsection may be used to calculate or to request commissioner approval of alternative surface water protection criteria. In addition, the commissioner may approve an alternative method of demonstrating compliance with surface water protection criteria under this subsection.

(1) Groundwater Plume Discharge to a Watercourse

(A) For a substance in a groundwater plume that discharges to an inland surface watercourse classified as AA, A, or B in the Water Quality Standards, alternative surface water protection criteria may be calculated. Any such calculation shall be performed by multiplying the applicable water quality criteria or, if there are no such water quality criteria, the criteria approved by the commissioner pursuant to subsection (i)(2) of this section, by a dilution factor derived from the following equation:

$$DF = (0.25 \times Q99)/Q_{\text{plume}}$$

Terms	Description	Value	Units
DF	Release-specific dilution factor	substance-specific	unitless
Q99	Daily stream flow equal to or exceeded on 99 percent of days in a year	waterbody-specific	ft ³ /sec
Q _{plume}	Average daily discharge of the subject groundwater plume: $Q_{\text{plume}} = KiA$	calculated	ft ³ /sec
K	Hydraulic conductivity	as measured	ft/sec
i	Hydraulic gradient	as measured	ft/ft
A	Area of discharge: $A = h * w$	as measured	ft ²
h	Thickness of groundwater plume at watercourse discharge area	as measured	ft
w	Width of groundwater plume at watercourse discharge area	as measured	ft

(B) For a substance in a groundwater plume that discharges to a coastal surface watercourse classified as SA or SB in the Water Quality Standards, alternative surface water protection criteria may be calculated. Any such calculation shall be performed by multiplying the applicable water quality criteria, or if there are no such water quality criteria, the criteria approved by the commissioner pursuant to subsection (i)(2) of this section, by a dilution factor derived from the following equation:

$$DF = ((W \times 0.25) \times L \times D)/(T \times Q_{\text{plume}})$$

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Terms	Description	Value	Units
D	Mean depth of the watercourse at mean low tide where the groundwater plume discharges	calculated	ft
DF	Release-specific dilution factor	substance-specific	unitless
L	Distance along which the groundwater plume intersects the watercourse discharge area	calculated	ft
W	Cross-sectional distance from one shoreline to the other for the tidally influenced watercourse under low tide conditions (0.25*watercourse width) where the maximum value for W is 100 feet	calculated	ft
T	Daily discharge duration	0.5	day
Q _{plume}	Average daily discharge of the subject groundwater plume: $Q_{plume} = KiA$	calculated	ft ³ /sec
K	Hydraulic conductivity	as measured	ft/day
i	Hydraulic gradient	as measured	ft/ft
A	Area of discharge: $A = h * w$	as measured	ft ²
h	Thickness of groundwater plume at watercourse discharge area	as measured	ft
w	Width of groundwater plume at watercourse discharge area	as measured	ft

(C) For purposes of this subdivision, no alternative surface water protection criteria shall exceed the maximum allowable alternative surface water protection criteria specified in the table below, which is the water quality criteria multiplied by a dilution factor calculated pursuant to subparagraph (A) or (B) of this subdivision.

Distance from compliance point to nearest downgradient surface water	Maximum Allowable Alternative SWPC
Less than or equal to 100 feet	100 times WQC
Greater than 100 feet to 200 feet	200 times WQC
Greater than 200 feet to 300 feet	300 times WQC
Greater than 300 feet to 400 feet	400 times WQC
Greater than 400 feet to 500 feet	500 times WQC
Greater than 500 feet to 600 feet	600 times WQC
Greater than 600 feet to 700 feet	700 times WQC
Greater than 700 feet to 800 feet	800 times WQC

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Distance from compliance point to nearest downgradient surface water	Maximum Allowable Alternative SWPC
Greater than 800 feet to 900 feet	900 times WQC
Greater than 900 feet	1,000 times WQC

(D) Written notice of the use of alternative surface water protection calculated by an LEP under this subdivision shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs and shall also include the calculation, value and basis of terms, and dilution factor used.

(2) Aquifer Dilution

(A) Alternative surface water protection criteria may be calculated in accordance with subparagraph (B) of this subdivision, provided that:

(i) The portion of the groundwater plume for which such alternative criteria are calculated is at least five hundred feet from the nearest downgradient surface water; and

(ii) A dilution ratio for such groundwater plume is calculated pursuant to the following equation, and such ratio is equal to or greater than five:

$$DR = RC/DC$$

Terms	Description	Value	Units
DR	Release-specific dilution ratio	calculated	unitless
RC	Groundwater concentration of a substance within the release area	as measured	µg/L
DC	Groundwater concentration no more than fifty feet downgradient from the location where the RC was collected	as measured	µg/L

(B) For substances in a groundwater plume that comply with subparagraph (A) of this subdivision, alternative surface water protection criteria shall be calculated by multiplying the surface water protection criteria, or if applicable the water quality criteria, by the dilution factor identified in the following table:

Distance to nearest downgradient surface water	Dilution factor
Greater than 500 feet to 600 feet	5
Greater than 600 feet to 700 feet	6
Greater than 700 feet to 800 feet	7
Greater than 800 feet to 900 feet	8
Greater than 900 feet to 1000 feet	9
Greater than 1000 feet	10

(C) Written notice of the use of alternative surface water protection criteria calculated by an LEP under this subparagraph shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs and shall also include the calculation, value and basis of terms, and dilution factor used.

(3) Commissioner Approval

The commissioner may approve or deny in writing a request for a release-specific alternative surface water protection criteria or an alternative method of demonstrating compliance with surface water protection criteria. No request under this subdivision shall be approved until it is demonstrated to the commissioner's satisfaction that such alternative criteria or alternative method for demonstrating compliance will protect all existing and proposed uses of surface water and is protective of human health and the environment. A request for such approval shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs. Upon receipt of such request the commissioner shall specify which of the following shall be provided to the commissioner:

(A) The Q99 stream flow rate of the surface water body into which the subject groundwater plume discharges;

(B) The identification of other surface water or groundwater discharges to the surface water body within one-half mile of the areal extent of the subject groundwater plume;

(C) A report on the instream water quality into which the subject groundwater plume discharges, including assessment and use attainment information in the most current integrated water quality report and any applicable total maximum daily loads; and

(D) The flow rate of the subject groundwater plume that discharges to the surface water body and the extent and degree of mixing of such discharge in such surface water.

(c) **Volatilization Criteria**

(1) Volatilization Criteria for Groundwater

(A) Residential Volatilization Criteria

Unless otherwise specified in this subsection, each volatile organic substance in groundwater shall be remediated to a concentration that is equal to or less than the residential volatilization criteria for groundwater.

(B) Industrial/Commercial Volatilization Criteria

Each volatile organic substance in groundwater may be remediated to a concentration that is equal to or less than the industrial/commercial volatilization criteria for groundwater, provided that the subject area above the groundwater polluted with volatile organic substances:

(i) Is not used for residential activity;

(ii) Has limited access only to those individuals working at or temporarily visiting for industrial/commercial activity; and

(iii) An EUR is in effect for the subject area or the entire parcel, which restriction shall:

(I) Prohibit residential activity; and

(II) Require compliance with clause (ii) of this subparagraph.

(C) Applicability of Volatilization Criteria

Subdivision (1) of this subsection shall apply to:

(i) Volatile organic substances, other than volatile petroleum substances, within thirty (30) feet or less of the ground surface and within thirty (30) feet or less of the lowest portion of a building under which groundwater is polluted with such substances; and

(ii) Volatile petroleum substances, within ten (10) feet or less of the ground surface and within ten (10) feet or less of the lowest portion of a building under which groundwater is polluted with such substances.

(2) Alternative Demonstration of Compliance with Volatilization Criteria for Groundwater

(A) Soil Vapor Below a Building

For volatile organic substances in groundwater, remediation to the volatilization criteria specified in subdivision (1) of this subsection may not be required if the concentration of such substances in soil vapors below a building is equal to or less than:

- (i) The residential volatilization criteria for soil vapor; or
- (ii) The industrial/commercial volatilization criteria for soil vapor, provided that to use such criteria, the requirements of subdivision (1)(B) of this subsection are satisfied.

(B) Concentrations at the Water Table

For volatile organic substances in groundwater, remediation to the volatilization criteria specified in subdivision (1) of this subsection may not be required if the substances in groundwater exceeding volatilization criteria are not at the water table and all of the laboratory analytical results from sampling the concentration of such substances at the water table, as seasonally demonstrated by groundwater monitoring representative of the uppermost portion of the water column are equal to or less than:

- (i) The residential volatilization criteria for groundwater; or
- (ii) The industrial/commercial volatilization criteria for groundwater, provided that to use such criteria, the requirements of subdivision (1)(B) of this subsection are satisfied.

(3) Exemption from Volatilization Criteria for Groundwater through Vapor Mitigation

For volatile organic substances in groundwater beneath an existing building, remediation to the volatilization criteria for groundwater specified in subdivision (1) of this subsection may not be required, provided that:

(A) Measures to prevent the migration of volatile organic substances into any overlying building have been implemented and submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs. The submittal shall also include:

- (i) A brief description of the measures implemented to control the migration of such volatile organic substances into any overlying building;
- (ii) A demonstration of the effectiveness of such control measures;
- (iii) The plan for monitoring the effectiveness of such control measures over time and maintaining such control measures in good condition; and
- (iv) A map showing all existing buildings, the areal extent of the groundwater plume, and the location of such control measures;

(B) The commissioner deems the measure proposed under subparagraph (A) of this subdivision acceptable and such measures have been and continue to be implemented and monitored; and

(C) An EUR, or other permanent control measures approved in writing by the commissioner, is or will be in effect for the subject area, which restriction or control measure shall:

- (i) Prohibit removal of any building above such volatile organic substances in groundwater; and
- (ii) Require compliance with:
 - (I) Control measures deemed acceptable by the commissioner under subparagraphs (A) and (B) of this subdivision; and

(II) Any condition specified by the commissioner in the approval of such permanent control measures under this subparagraph.

(4) Alternative Release-Specific Volatilization Criteria and Alternative Method of Demonstrating Compliance with Volatilization Criteria

With respect to volatile organic substances in groundwater or soil vapor for which volatilization criteria are specified in Appendix E or Appendix F of the RSRs or approved by the commissioner pursuant to subsection (i)(3) of this section, the commissioner may approve or deny in writing a request for a release-specific alternative volatilization criteria. In addition, the commissioner may approve or deny in writing an alternative method of determining compliance with such criteria.

(A) A request for approval of alternative volatilization criteria or for an alternative method of demonstrating compliance with volatilization criteria shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and shall also include:

(i) A description of the distribution and concentration of volatile organic substances in groundwater or soil vapor beneath any overlying building;

(ii) A description of any site-specific conditions, including, but not limited to, the value of all terms used and the source of any release-specific values.

(B) No request under subparagraph (A) of this subdivision shall be approved unless such request demonstrates to the commissioner's satisfaction that such criteria or alternative method of determining compliance is protective of human health and will ensure that volatile organic substances in groundwater or soil vapor do not accumulate in the air of any building at a concentration which:

(i) For any carcinogenic substance, creates a risk to human health in excess of a 10^{-6} excess lifetime cancer risk level, and for any non-carcinogenic substance, is equal to or less than a hazard index of one (1); and

(ii) For a groundwater plume or soil vapor polluted with ten (10) or more volatile organic substances, does not exceed a cumulative excess cancer risk level of 10^{-5} for carcinogenic substances, and for non-carcinogenic substances with the same target organ, the cumulative hazard index does not exceed one (1).

(C) Any approval of the commissioner under this subdivision, may require that an EUR is or will be in effect for the subject area, which restriction shall require compliance with any conditions specified by the commissioner when issuing such approval.

(5) Exemption from Volatilization Criteria for Groundwater Through a No Build Restriction

For volatile organic substances in groundwater, remediation to the applicable volatilization criteria specified in subdivision (1) of this subsection may not be required if the following conditions are satisfied:

(A) The water table is less than thirty (30) feet below the ground surface;

(B) No building exists over the groundwater polluted with such substances at a concentration above applicable volatilization criteria;

(C) One of the following has been satisfied:

(i) An EUR is in effect for the subject area, which restriction shall;

(I) Prohibit construction of a building at the subject area; and

(II) Require compliance with subparagraph (B) of this subdivision;

(ii) The commissioner has approved in writing a request demonstrating that no building can reasonably be expected to be constructed over the subject groundwater; or

(iii) The commissioner has approved in writing a request demonstrating that natural attenuation or other methods of remediation will, within five (5) years, reduce the concentration of volatile organic substances in such groundwater to a concentration equal to or less than:

(I) Residential volatilization criteria; or

(II) The industrial/commercial volatilization criteria, in which case subdivision (1)(A)(ii) of this subsection shall apply; and

(D) For any volatile organic substances, other than volatile petroleum substances, that exceed the applicable volatilization criteria within thirty (30) feet of any part of a building, the potential for a vapor intrusion pathway into such building shall be thoroughly evaluated. If such evaluation identifies a vapor intrusion pathway into such building, compliance with subdivision (3) of this subsection shall be required.

(6) Exemption from Volatilization Criteria Through Indoor Air Monitoring

For volatile organic substances in groundwater, remediation to the applicable volatilization criteria specified in subdivision (1) of this subsection may not be required for groundwater underlying an existing building. No request under subparagraph (A) of this subdivision shall be approved unless such request demonstrates to the commissioner's satisfaction that the conditions in the building overlying volatile organic substances in groundwater are protective of human health and the environment.

(A) A request in accordance with this subdivision shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and shall also include:

(i) The acknowledgement and consent of the owner of the building for which approval of the air monitoring program is sought; and

(ii) An indoor air monitoring program and measures to control the level of any such volatile organic substances in the air of the subject building, including, but not limited to:

(I) A description of the distribution and concentration of volatile organic substances beneath the building;

(II) Any measures to be taken;

(III) The location of proposed monitoring points;

(IV) The proposed frequency of monitoring;

(V) The parameters to be monitored; and

(VI) The actions to be taken in the event such monitoring indicates that selected parameters are exceeded.

(B) The commissioner may approve or deny in writing a request submitted under this subdivision. Approval of any indoor air monitoring program pursuant to this subdivision shall require that an ELUR is or will be in effect for the subject area, which restriction shall require compliance with the indoor air monitoring program approved by the commissioner in writing, including any conditions imposed by the commissioner when approving such program.

(7) For the purpose of this subsection, "building" means any structure enclosed by a roof and walls that is capable of accumulating vapors from the subsurface.

(d) **Groundwater Protection Criteria**

(1) Exemption from Attaining Background Concentration in a GA Area

For substances in groundwater in a GA area, remediation to the background concentration may not be required if the concentration of each substance in a groundwater plume is equal to or less than the groundwater protection criteria and one of the following conditions exist:

(A) (i) A public water supply distribution system is available within two hundred (200) feet of the parcel on which the release area is located, within two hundred (200) feet of all adjacent parcels, and within two hundred (200) feet of any parcel within the areal extent of the groundwater plume;

(ii) Such groundwater plume is not located in an aquifer protection area; and

(iii) Such groundwater plume is not located within the area of influence of any public water supply well;

(B) Prior to any soil or groundwater remediation, the groundwater plume is a diminishing state groundwater plume; or

(C) Each substance in groundwater is remediated to a concentration equal to or less than the groundwater protection criteria, and further reduction of the concentrations of such substances to the background concentration cannot be achieved using sound engineering and hydrogeologic remediation practices.

(2) Alternative Groundwater Protection Criteria

With respect to substances in groundwater for which groundwater water protection criteria are specified in Appendix C of the RSRs, or approved by the commissioner pursuant to subsection (i)(1) of this section, alternative groundwater protection criteria may be calculated by an LEP pursuant to subdivision (3) of this subsection or approved in writing by the commissioner pursuant to subdivision (4) or (5) of this subsection.

(3) LEP Calculation of Alternative Groundwater Protection Criteria

(A) For a substance in groundwater located in an area designated on the department's "Potential Alternative Groundwater Protection Criteria Map" in Appendix I of the RSRs, alternative groundwater protection criteria may be calculated by an LEP, in accordance with subparagraph (B) or (C) of this subdivision, as applicable, provided that:

(i) Written notice of the use of alternative groundwater protection criteria is submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and any such notice includes:

(I) The alternative groundwater protection criteria calculation in accordance with subparagraph (B) or (C) of this subdivision; and

(II) Documentation demonstrating compliance with the requirements of this subdivision, including, but not limited to, a water supply well receptor survey;

(ii) Any alternative groundwater protection criteria shall not exceed:

(I) One hundred (100) times the groundwater protection criteria specified in Appendix C of the RSRs or approved by the commissioner in accordance with subsection (i)(1) of this section; and

(II) The residential volatilization criteria for groundwater specified in Appendix E of the RSRs or approved by the commissioner in accordance with subsection (i)(3) of this section;

(iii) No public or private drinking water supply well is present on any subject parcel within or adjacent to the areal extent of the portion of the subject groundwater plume in which a substance exceeds the background concentration;

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(iv) A public water supply distribution system is available within five hundred (500) feet downgradient and two hundred (200) feet in any direction of the subject groundwater plume;

(v) All releases to soil that constitute a source of pollution resulting in the subject groundwater plume have been remediated so there is no longer an on-going source in soil impacting groundwater;

(vi) No alternative pollutant mobility criteria is used for the same substance for which an alternative groundwater protection criteria is used;

(vii) The subject groundwater plume is a diminishing state groundwater plume; and

(viii) The alternative groundwater protection criteria being calculated is not used for any portion of the subject groundwater plume located in bedrock unless approved by the commissioner in accordance with subdivision (5) of this subsection.

(B) For volatile organic substances, the following equation shall be used to calculate alternative groundwater protection criteria in accordance with this subdivision:

$$\text{Alternative GWPC} = \frac{\text{TAC} \times \text{HV} \times \text{ER} \times \text{MC}}{\text{f} \times \text{WFR}}$$

Terms	Description	Value	Units
Alternative GWPC	Criteria in groundwater as alternative to groundwater protection criteria	calculated	µg/L
TAC	Target Indoor Air Concentration as approved by the commissioner in accordance with Appendix G of the RSRs	substance-specific	µg/m ³
f	Fraction of substance concentration volatilized	0.5	unitless
HV	House Volume	1,000	m ³
ER	Air exchange rate per day, as a time weighted average	134	times per day
MC	Mixing coefficient	0.33	none
WFR	Water Flow Rate	3,183	L/day

(C) For semi-volatile organic substances, inorganic substances and pesticides, the following equation shall be used to calculate alternative groundwater protection criteria in accordance with this subdivision:

$$\text{Alternative GWPC} = \text{WSF} \times \text{RSC} \times \text{DEC} \times \text{UCF}$$

Terms	Description	Value	Units
Alternative GWPC	Criteria in groundwater as alternative to groundwater protection criteria	calculated	µg/L
WSF	Water to soil concentration factor, based upon accumulation of arsenic in soil	0.02	(mg/L)/ (mg/kg)

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Terms	Description	Value	Units
RSC	Relative source contribution to account for other background contributions to semi-volatile organic substances in soil	0.2	unitless
DEC	Residential direct exposure criteria in Appendix A of the RSRs or criteria approved by the commissioner pursuant to section 22a-133k-2(b)(7) of the RSRs	substance-specific	mg/kg
UCF	Unit Conversion Factor	1,000	µg/mg

(4) Commissioner Approval of Alternative Groundwater Protection Criteria Not In Mapped Areas

For a substance in groundwater that is not located in an area designated on the department's "Potential Alternative Groundwater Protection Criteria Map" in Appendix I of the RSRs, the commissioner may approve or deny in writing a request for an alternative groundwater protection criteria pursuant to this subparagraph. A request for such alternative groundwater protection criteria shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs. No request shall be approved unless such request demonstrates to the commissioner's satisfaction:

(A) Compliance with the requirements of clauses (i) to (viii), inclusive, of subdivision (3)(A) of this subsection;

(B) Calculation of proposed alternative groundwater protection criteria in accordance with subparagraphs (B) and (C) of subdivision (3) of this subsection, as applicable; and

(C) Compliance with clause (i) or (ii) of this subparagraph.

(i) Documentation from a public or private water company subject to regulation by the Department of Public Health demonstrating that public drinking water is available in the area where the subject groundwater plume is located, including a public water service area map on file with the Department of Public Health indicating that public water is available. This clause can be used only if:

(I) A public water supply distribution system has become available to any parcel within or adjacent to the areal extent of the portion of the groundwater plume not previously included on the department's "Potential Alternative Groundwater Protection Criteria Map" in Appendix I of the RSRs; and

(II) The subject groundwater plume is not located in an aquifer protection area or in an aquifer suitable for development of a public water supply.

(ii) As a result of stratified drift aquifer conditions where the subject groundwater plume is located:

(I) The aquifer is not suitable for development of a public water supply due to the hydrogeology, depth, saturated thickness of the surficial materials or other hydrogeologic factors;

(II) There is less than twenty (20) feet of saturated sand or sand and gravel in such aquifer or pumping more than fifteen (15) gallons per minute from such aquifer is not sustainable for public water use; and

(III) A cross-sectional map is provided showing the nature and distribution of surficial materials in such aquifer.

(5) Commissioner Approval of Alternative Groundwater Protection Criteria Where Any Portion of a Plume Is In Bedrock

For a substance in groundwater that is located in an area designated on the department's "Potential Alternative Groundwater Protection Criteria Map" in Appendix I of the RSRs, and where the portion of the groundwater plume is located in bedrock. A request for such alternative groundwater protection criteria shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs. No request shall be approved unless such request includes a map showing the horizontal and vertical extent of the bedrock groundwater plume that exceeds or could be expected to exceed the groundwater protection criteria and demonstrates to the commissioner's satisfaction:

(A) Compliance with the requirements of clauses (i) to (vii), inclusive, of subdivision (3)(A) of this subsection; and

(B) That the groundwater plume that exceeds the groundwater protection criteria will not pose a risk to human health and the environment.

(e) Technical Impracticability Variance

Groundwater may be eligible for a variance from compliance with the surface water protection criteria or the groundwater protection criteria if the commissioner determines that compliance with such criteria is technically impracticable. No request for a variance shall be approved unless such request demonstrates to the commissioner's satisfaction that the requirements of this subsection have been satisfied.

(1) Request for Technical Impracticability Variance

(A) A request for a technical impracticability variance shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and shall also include:

(i) The substance and its concentration in the groundwater plume for which a variance is sought;

(ii) A map showing the horizontal and vertical extent of the groundwater plume that exceeds or could be expected to exceed surface water protection criteria or groundwater protection criteria;

(iii) A demonstration of compliance with the soil standards in section 22a-133k-2 of the RSRs, and unless it is demonstrated that remediation of soil is technically impracticable, that polluted soil is not contributing to the groundwater plume;

(iv) Laboratory analytical results of all representative sampling before, during, and after the implementation of such actions and a description of all actions to remediate the groundwater plume;

(v) A feasibility study for achieving compliance with the criteria for which a variance is sought that evaluates remediation methods and demonstrates that achieving compliance with such criteria in a reasonable timeframe is technically impracticable;

(vi) A demonstration that the subject groundwater plume is in a steady-state or is a diminishing state groundwater plume, or that the subject groundwater plume is hydraulically controlled;

(vii) A map and description of the proposed TI zone, including the identification of existing groundwater withdrawals and potential for future withdrawal of groundwater on

parcels within and adjacent to the proposed TI zone, and a demonstration that such withdrawals will not induce movement of the subject groundwater plume into uncontaminated areas or adversely affect the protectiveness of the proposed variance;

(viii) A study to determine the risks posed by the polluted groundwater that would remain if a variance was granted. If such study shows a risk or a potential risk to human health or the environment, a contingency plan to eliminate or minimize such risk shall be included;

(ix) Measures for long-term monitoring, operation, maintenance, and reporting, to ensure that the selected remedy remains effective in its protectiveness. Such measures shall:

(I) Demonstrate through groundwater monitoring that the groundwater plume is not increasing in size or concentration, or otherwise migrating in a manner that would alter the risk assumptions of clause (viii) of this subparagraph;

(II) Confirm that unacceptable risks to human health and the environment do not occur and if such risks do occur, contingency actions will be taken to abate such risks, including, but not limited to, changes in land use; and

(III) Demonstrate through monitoring that any proposed operation and maintenance controls are working properly and remain effective; and

(x) The type and estimated amount of financial assurance to be posted in accordance with the requirements of section 22a-133k-1(f) of the RSRs.

(B) Based upon the information submitted in accordance with subparagraph (A) of this subdivision, the commissioner shall indicate, in writing, either that a groundwater plume does not qualify for a variance under this subsection, or alternatively, that the information specified in subdivision (2) of this subsection shall be submitted and may include conditions the commissioner deems appropriate to protect public health and the environment.

(2) Additional Information to be Submitted Upon Request

After submission of the information required in this subdivision, the commissioner may approve or deny in writing a request for a technical impracticability variance. Unless otherwise specified by the commissioner, the following information shall be submitted within one hundred and twenty (120) days of a request for such information by the commissioner. The information shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and shall also include:

(A) A demonstration that public notice has been provided in accordance with section 22a-133k-1(d) of the RSRs;

(B) A certification that written notice of the extent and degree of such pollution allowed to remain in place has been provided to each owner of record of each parcel within the TI zone, at the address for such owner on the last-completed grand list of the municipality where the parcel is located, and to the Director of Health of the municipality or municipalities in which the TI zone is located;

(C) If the commissioner has specified that an ELUR is required, the acknowledgement and consent from the owner of each parcel in the TI zone to such variance;

(D) A demonstration that financial assurance has been obtained in accordance with section 22a-133k-1(f) of the RSRs; and

(E) A demonstration, as specified by the commissioner in the written request for information under this subdivision, that either an ELUR is in effect on each parcel in the TI zone or other permanent control measure is in place. Any ELUR or other permanent control

measure shall:

(i) Require compliance with the plan and measures specified in clauses (viii) and (ix) of subdivision (1)(A) of this subsection;

(ii) Include conditions the commissioner deems appropriate to protect public health and the environment;

(iii) In addition to any requirement in the EUR Regulations, require the preparation of a report every five (5) years, which reviews the implementation and effectiveness of the variance approved by the commissioner, including, but not limited to, the impact of the use of groundwater on parcels adjacent to the TI zone. Such reports shall be maintained by the parcel owner who is requesting such variance until the technical impracticability variance is no longer required under this subsection and shall be provided to the commissioner upon request; and

(iv) In addition, for a variance from compliance with the groundwater protection criteria:

(I) Prohibit the use of groundwater for drinking or other purposes; and

(II) Prohibit the withdrawal of groundwater, unless a withdrawal has been approved in writing by the commissioner.

(f) Conditional Exemption for Incidental Sources

Compliance with the groundwater criteria specified in subsection (a) of this section is not required for the following substances in groundwater under the circumstances described in this subsection:

(1) Trihalomethanes or any other substance within drinking water released from a public water supply distribution system; or

(2) Metals, petroleum hydrocarbons, or semi-volatile organic substances, provided such substances are the result of:

(A) An incidental release due to the normal operation of motor vehicles, not including refueling, repair or maintenance of a motor vehicle; or

(B) Normal paving and maintenance of a consolidated bituminous concrete surface provided such bituminous concrete surface has been maintained for its intended purpose.

(g) Conditional Exemption for Groundwater Polluted with Pesticides

Compliance with the groundwater criteria specified in subsection (a) of this section is not required for pesticides in groundwater resulting from the application of pesticides at the release area, provided that:

(1) A determination has been made that such pesticides are present solely as a result of the application of pesticides;

(2) Compliance with the soil standards in section 22a-133k-2 of the RSRs has been achieved for any release of pesticides;

(3) The nature and approximate extent of pesticides in the groundwater has been evaluated;

(4) Potable water supply wells on the parcel where pesticides are in groundwater have been sampled and any exposure pathway to drinking water in such wells is eliminated or mitigated to the extent necessary to protect human health;

(5) A potable water supply well receptor survey identifying surrounding drinking water uses has been conducted;

(6) With respect to the parcel for which a demonstration of compliance with the RSRs

is being made, if pesticides in the groundwater on such parcel exceed the groundwater criteria a notice is recorded on the municipal land records identifying such exceedance;

(7) If pesticides applied at a parcel, for which a demonstration of compliance with the RSRs is being made, are present in groundwater on other parcels at concentrations exceeding the groundwater criteria, best efforts have been made to ensure that an EUR has been placed providing notice that pesticides in groundwater on such affected parcels exceeds the groundwater criteria. A certification stating such best efforts have been made shall be submitted with the notice required under subdivision (8) of this section; and

(8) Notice of compliance with the requirements of this subsection, including all documents demonstrating such compliance, is submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and is also submitted to the Director of Health of the municipality in which such pesticides in groundwater are located.

(h) Applying the Groundwater Criteria

Compliance with the standards for groundwater in this section, or standards specified in section 22a-133k-2 of the RSRs that refer to or require groundwater monitoring, shall be based upon groundwater monitoring conducted in compliance with this subsection.

(1) Groundwater monitoring shall be capable of determining:

(A) The conceptual site model for the release is valid;

(B) The background concentration at the nearest location upgradient of and unaffected by the release;

(C) The effectiveness of any soil remediation to prevent the pollution of groundwater by substances from the release area;

(D) The effectiveness of any measures to render soil environmentally isolated;

(E) The effectiveness of any remediation to eliminate or minimize any risks to human health and the environment associated with each release being remediated, including, but not limited to, any risks identified during remediation or identified in any risk assessment conducted in accordance with subsection (e)(2) of this section;

(F) Whether the concentration of a substance in groundwater is equal to or less than the applicable groundwater criteria for such substance;

(G) Whether a ground-water groundwater plume in a GB area interferes with any existing use of groundwater, including, but not limited to, a drinking water supply or an industrial, agricultural, or commercial use of groundwater; and

(H) The effectiveness of monitored natural attenuation to achieve compliance with groundwater criteria within a reasonable timeframe.

(2) Pre-requisites for Determining Compliance with Groundwater Criteria

The groundwater samples that will be used in determining compliance with an applicable criteria for a substance shall be collected after:

(A) All remedial actions conducted to achieve compliance with pollutant mobility criteria and the applicable groundwater criteria for such substance have been concluded, other than natural attenuation of a groundwater plume or the recording of an EUR;

(B) The aquifer is no longer subject to the transient effects on hydraulic head attributable to withdrawal from or injection to groundwater for the purpose of remediation, or other effects due to site redevelopment or remediation;

(C) Any changes to the geochemistry induced by remedial actions or monitoring well

construction methods that might influence the concentration of such substance have stabilized and equilibrium geochemical conditions are established; and

(D) The groundwater plume is a diminishing state groundwater plume.

(3) Determining Compliance with Groundwater Criteria

With the exception of monitoring conducted in accordance with subparagraph (B)(ii) or (C)(ii) of this subdivision, when determining compliance with applicable groundwater criteria for substances, a minimum of four (4) sampling events shall be performed which reflect seasonal variability on a quarterly basis, provided that all sampling events used to demonstrate compliance are performed within two (2) years prior to the most current sampling event used to determine compliance, and shall comply with this subdivision.

(A) Determining Compliance with Groundwater Protection Criteria or the Background Concentration

Compliance with the groundwater protection criteria or the background concentration for each substance in groundwater is achieved when sampling locations used for compliance are representative of the subject groundwater plume, and either:

(i) All laboratory analytical results for such substance at all sampling locations are equal to or less than the groundwater protection criteria or the background concentration, whichever is applicable; or

(ii) The ninety-five percent upper confidence level of the arithmetic mean of a statistically representative sampling data set consisting of all laboratory analytical results for such substance for no less than twelve consecutive monthly samples, calculated individually for each sampling location, is equal to or less than the groundwater protection criteria or the background concentration, whichever is applicable.

(B) Determining Compliance with Surface Water Protection Criteria or Water Quality Criteria

Compliance with the surface water protection criteria for each substance in groundwater is achieved when sampling locations are representative of the subject groundwater plume, and either

(i) For sample locations in that portion of such groundwater plume which is upgradient of the area at which such groundwater discharges to the receiving surface water body:

(I) All laboratory analytical results for such substance are less than or equal to the surface water protection criteria or, if applicable, the water quality criteria; or

(II) The ninety-five (95) percent upper confidence level of the arithmetic mean of a statistically representative sampling data set consisting of all laboratory analytical results for such substance for no less than twelve (12) consecutive monthly samples, calculated individually for each sampling location, is equal to or less than the surface water protection criteria or, if applicable, the water quality criteria; or

(ii) The ninety-five (95) percent upper confidence level of the arithmetic mean of a statistically representative sampling data set consisting of all laboratory analytical results for such substance in the entire groundwater plume, collected to reflect seasonal variability on a quarterly basis, is equal to or less than the surface water protection criteria or, if applicable, the water quality criteria.

(C) Determining Compliance with Volatilization Criteria

(i) Compliance with volatilization criteria for each substance in groundwater is achieved

when the sampling is representative of the subject groundwater plume and all laboratory analytical results for such substance are equal to or less than the applicable volatilization criteria for groundwater.

(ii) Compliance with volatilization criteria for each substance in soil vapor is achieved when the sampling is representative of the subject soil vapor, including during the heating and cooling seasons, and the results of all laboratory analytical results for such substance are equal to or less than the applicable volatilization criteria for soil vapor.

(D) Alternative Methods to Determine Compliance with the Groundwater Criteria

The commissioner may approve or deny in writing a request for an alternative to the methods prescribed in this subdivision to determine compliance with an applicable groundwater criteria. Such proposed alternative methods may be based upon emerging technologies and approaches for which guidance, a standard, or an industrial code has been published by a regulatory agency, governmental advisory group, or other recognized professional organization. A request under this subdivision shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and shall also include any other information that the commissioner deems necessary to evaluate such request. Any approval by the commissioner may specify conditions necessary to protect human health and the environment.

(4) Upgradient Groundwater Plume

(A) In the circumstance where it is demonstrated that substances in a groundwater plume from an upgradient parcel are migrating onto the subject downgradient parcel, the concentrations of such substances in the groundwater plume at the downgradient parcel may be equal to or less than the concentrations of such substances found in the groundwater plume at the boundary between such parcels, provided that:

(i) Soil on the downgradient parcel has been remediated and compliance with the standards for soil in section 22a-133k-2 of the RSRs has been achieved;

(ii) At the downgradient parcel, all exposure pathways to drinking water supply wells and from volatilization of volatile organic substances into buildings have been eliminated or mitigated to the extent necessary to protect human health; and

(iii) Such substances are not already present in a groundwater plume at the downgradient parcel.

(B) In the circumstance where it is demonstrated that substances in a groundwater plume from an upgradient parcel are migrating onto a downgradient parcel and such substances have co-mingled with the same substances found in a groundwater plume at the downgradient parcel, in addition to the requirements in subparagraph (A) of this subdivision:

(i) The co-mingled groundwater plume on the downgradient parcel may be equal to or less than the concentrations of such substances found in the groundwater plume at the boundary between such parcels; and

(ii) All exposure pathways to drinking water supply wells and from volatilization of volatile organic substances into buildings at all parcels impacted by the groundwater plume emanating from the downgradient parcel have been eliminated or mitigated to the extent necessary to protect human health.

(C) Notice of the use of this provision as part of remediation shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs and shall demonstrate

compliance with this subdivision.

(D) This section does not apply to substances in a groundwater plume on a downgradient parcel where such substances are not migrating onto such parcel from an upgradient parcel or such substances are different than those migrating onto such parcel.

(i) **Additional Polluting Substances**

(1) Groundwater Protection Criteria for Additional Polluting Substances

(A) Any substance in groundwater for which a groundwater protection criterion is not specified in Appendix C of the RSRs, shall be remediated to the background concentration or to criteria obtained pursuant to this subdivision. A request under this subdivision shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and shall also include:

(i) A proposed risk-based groundwater protection criteria for each substance calculated in accordance with Appendix G of the RSRs;

(ii) The laboratory reporting limit for each substance;

(iii) A description of the organoleptic properties of each substance; and

(iv) Any information about the health effects such substance may cause due to exposure not accounted for in the proposed risk-based groundwater protection criteria.

(B) The commissioner may approve or deny in writing a request made under subparagraph (A) of this subdivision. No request shall be approved unless it is demonstrated to the commissioner's satisfaction that the requirements of this subdivision have been satisfied and that the proposed groundwater protection criteria will be protective of human health and the environment.

(C) Unless prohibited in writing by the commissioner, criteria approved by the commissioner pursuant to subparagraph (B) of this subdivision, may be the subject of a request for alternative criteria under subsection (d)(2) of this section.

(2) Surface Water Protection Criteria for Additional Polluting Substances

(A) Any substance in groundwater for which a surface water protection criterion is not specified in Appendix D of the RSRs or for which there are no water quality criteria, shall be remediated to the background concentration or to criteria obtained pursuant to this subdivision. A request under this subdivision shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and shall also include:

(i) A proposed risk-based surface water protection criteria for each substance calculated in accordance with Appendix G of the RSRs;

(ii) The laboratory reporting limit for each substance;

(iii) A description of the bioaccumulative properties of each substance; and

(iv) Any information about the ecological effects each substance may cause due to exposure not accounted for in the proposed risk-based surface water protection criteria.

(B) The commissioner may approve or deny in writing a request made under subparagraph (A) of this subdivision. No request shall be approved unless it is demonstrated to the commissioner's satisfaction that the requirements of this subdivision have been satisfied and that the proposed surface water protection criteria will be protective of human health and the environment.

(C) Unless prohibited in writing by the commissioner, criteria approved by the commissioner pursuant to subparagraph (B) of this subdivision, may be the subject of a

request for alternative criteria under subsection (b) of this section.

(3) Volatilization Criteria for Additional Polluting Substances

(A) Any substance in groundwater for which a volatilization criterion is not specified in Appendix E or Appendix F of the RSRs, shall be remediated to the background concentration or to criteria obtained pursuant to this subdivision. Such request may include target indoor air concentrations and volatilization criteria to apply to such substances in groundwater or soil vapor. A request under this subdivision shall be submitted to the commissioner in accordance with section 22a-133k-1(g) of the RSRs, and shall also include:

- (i) A risk-based target indoor air concentration or volatilization criteria for each substance calculated in accordance with Appendix G of the RSRs;
- (ii) The laboratory reporting limit for each substance;
- (iii) A description of the odor threshold of each substance; and
- (iv) Any information about the health effects each substance may cause due to exposure not accounted for in the proposed risk-based volatilization criteria.

(B) Such volatilization criteria shall ensure that such target indoor air concentrations will not be exceeded above the polluted groundwater.

(C) The commissioner may approve or deny in writing a request made under subparagraph (A) of this subdivision. No request shall be approved unless it is demonstrated to the commissioner's satisfaction that the requirements of this subdivision have been satisfied and that the proposed volatilization criteria will be protective of human health and the environment.

(D) Unless prohibited in writing by the commissioner, criteria approved by the commissioner pursuant to subparagraph (C) of this subdivision, may be the subject of a request for alternative criteria under subsection (c)(4) of this section.

(j) **Additional Remediation of Groundwater**

Nothing in the RSRs shall preclude the commissioner from taking any action necessary to prevent or abate pollution, or to prevent or abate any threat to human health or the environment. If the presence of any substance impairs the aesthetic quality of any groundwater which is or can reasonably be expected to be a source of water for drinking or other uses, additional remediation shall be conducted in order to reduce the concentration of such substance to a concentration appropriate for such use.

Appendix A to the RSRs

Direct Exposure Criteria for Soil

Substance	Residential DEC in mg/kg(ppm)	Industrial/Commercial DEC in mg/kg(ppm)
Volatile Organic Substances		
Acetone	500	1,000
Acrylonitrile	1.1	11
Benzene	21	200
Bromoform	78	720
2-Butanone (MEK)	500	1,000

Regulations of Connecticut State Agencies

Substance	Residential DEC in mg/kg(ppm)	Industrial/Commercial DEC in mg/kg(ppm)
Carbon tetrachloride	4.7	44
Chlorobenzene	500	1,000
Chloroform	100	940
Dibromochloromethane	7.3	68
1,2-Dichlorobenzene	500	1,000
1,3-Dichlorobenzene	500	1,000
1,4-Dichlorobenzene	26	240
1,1-Dichloroethane	500	1,000
1,2-Dichloroethane	6.7	63
1,1-Dichloroethylene	1	9.5
cis-1,2-Dichloroethylene	500	1,000
trans-1,2-Dichloroethylene	500	1,000
1,2-Dichloropropane	9	84
1,3-Dichloropropene	3.4	32
Ethylbenzene	500	1,000
Ethylene dibromide (EDB)	0.007	0.067
Methyl-tert-butyl-ether	500	1,000
Methyl isobutyl ketone	500	1,000
Methylene chloride	82	760
Styrene	500	1,000
1,1,1,2-Tetrachloroethane	24	220
1,1,2,2-Tetrachloroethane	3.1	29
Tetrachloroethylene	12	110
Toluene	500	1,000
1,1,1-Trichloroethane	500	1,000
1,1,2-Trichloroethane	11	100
Trichloroethylene	56	520
Vinyl chloride	0.32	3
Xylenes	500	1,000
Semi-volatile Organic Substances		
Acenaphthylene	1,000	2,500
Anthracene	1,000	2,500

Regulations of Connecticut State Agencies

Substance	Residential DEC in mg/kg(ppm)	Industrial/Commercial DEC in mg/kg(ppm)
Benzo(a)anthracene	1	7.8
Benzo(b)fluoranthene	1	7.8
Benzo(k)fluoranthene	8.4	78
Benzo(a)pyrene	1	1
Bis(2-chloroethyl)ether	1	5.2
Bis(2-chloroisopropyl) ether	8.8	82
Bis(2-ethyl hexyl) phthalate	44	410
Butyl benzl phthalate	1,000	2,500
2-chlorophenol	340	2,500
Di-n-butyl phthalate	1,000	2,500
Di-n-octyl phthalate	1,000	2,500
2,4-Dichlorophenol	200	2,500
Fluoranthene	1,000	2,500
Fluorene	1,000	2,500
Hexachloroethane	44	410
Hexachlorobenzene	1	3.6
Naphthalene	1,000	2,500
Pentachlorophenol	5.1	48
Phenanthrene	1,000	2,500
Phenol	1,000	2,500
Pyrene	1,000	2,500
Inorganic Substances		
Antimony	27	8,200
Arsenic	10	10
Barium	4,700	140,000
Beryllium	2	2
Cadmium	34	1,000
Chromium, trivalent	3,900	51,000
Chromium, hexavalent	100	100
Copper	2,500	76,000
Cyanide	1,400	41,000
Lead	400	1,000

Regulations of Connecticut State Agencies

Substance	Residential DEC in mg/kg(ppm)	Industrial/Commercial DEC in mg/kg(ppm)
Mercury	20	610
Nickel	1,400	7,500
Selenium	340	10,000
Silver	340	10,000
Thallium	5.4	160
Vanadium	470	14,000
Zinc	20,000	610,000
Pesticides, PCBs and Extractable Total Petroleum Hydrocarbons		
Alachlor	7.7	72
Aldicarb	14	410
Atrazine	2.8	26
Chlordane	0.49	2.2
Dieldrin	0.038	0.36
Endrin	20	610
2-4 D	680	20,000
Heptachlor epoxide	0.067	0.63
Heptachlor	0.14	1.3
Lindane	20	610
Methoxychlor	340	10,000
Toxaphene	0.56	5.2
PCBs (The use of the Industrial/Commercial DEC requires the parcel to be used pursuant to section 22a-133k-2(b)(4), and in accordance with title 40 CFR Part 761)	1	10
TPH- Total Petroleum Hydrocarbons by EPA Method 418.1 (This method shall not be used for the analysis of samples collected after June 30, 2009)	500	2,500
Extractable Total Petroleum Hydrocarbons by ETPH Analysis	500	2,500

Appendix B to the RSRs

Regulations of Connecticut State Agencies

Pollutant Mobility Criteria for Soil

Substance	GA Area PMC in mg/kg (ppm)	GB Area PMC in mg/kg (ppm)
Volatile Organic Substances		
Acetone	14	140
Acrylonitrile	0.01	0.1
Benzene	0.02	0.2
Bromoform	0.08	0.8
2-Butanone (MEK)	8	80
Carbon tetrachloride	0.1	1
Chlorobenzene	2	20
Chloroform	0.12	1.2
Dibromochloromethane	0.01	0.1
1,2-Dichlorobenzene	3.1	3.1
1,3-Dichlorobenzene	12	120
1,4-Dichlorobenzene	1.5	15
1,1-Dichloroethane	1.4	14
1,2-Dichloroethane	0.02	0.2
1,1-Dichloroethylene	0.14	1.4
cis-1,2-Dichloroethylene	1.4	14
trans-1,2-Dichloroethylene	2	20
1,2-Dichloropropane	0.1	1.0
1,3-Dichloropropene	0.01	0.1
Ethyl benzene	10.1	10.1
Ethylene dibromide (EDB)	0.01	0.1
Methyl-tert-butyl-ether	2	20
Methyl isobutyl ketone	7	14
Methylene chloride	0.1	1.0
Styrene	2	20
1,1,1,2-Tetrachloroethane	0.02	0.2
1,1,2,2-Tetrachloroethane	0.01	0.1
Tetrachloroethylene	0.1	1
Toluene	20	67
1,1,1-Trichloroethane	4	40

Regulations of Connecticut State Agencies

Substance	GA Area PMC in mg/kg (ppm)	GB Area PMC in mg/kg (ppm)
1,1,2-Trichloroethane	0.1	1
Trichloroethylene	0.1	1.0
Vinyl chloride	0.04	0.40
Xylenes	19.5	19.5
Semi-volatile Organic Substances		
Acenaphthylene	8.4	84
Anthracene	40	400
Benzo(a)anthracene	1	1
Benzo(b)fluoranthene	1	1
Benzo(k)fluoranthene	1	1
Benzo(a)pyrene	1	1
Bis(2-chloroethyl)ether	1	2.4
Bis(2-chloroisopropyl)ether	1	2.4
Bis(2-ethyl hexyl)phthalate	1	11
Butyl benzl phthalate	20	200
2-chlorophenol	1	7.2
Di-n-butyl phthalate	14	140
Di-n-octyl phthalate	2	20
2,4-Dichlorophenol	1	4
Fluoranthene	5.6	56
Fluorene	5.6	56
Hexachloroethane	1	1
Hexachlorobenzene	1	1
Naphthalene	5.6	56
Pentachlorophenol	1	1
Phenanthrene	4	40
Phenol	80	800
Pyrene	4	40
Pesticides and Extractable Total Petroleum Hydrocarbons		
Alachlor	0.230	0.4
Aldicarb	1	1
Atrazine	0.2	0.2

Regulations of Connecticut State Agencies

Substance	GA Area PMC in mg/kg (ppm)	GB Area PMC in mg/kg (ppm)
Chlordane	0.066	0.066
Dieldrin	0.007	0.007
2-4 D	1.4	14
Heptachlor epoxide	0.02	0.02
Heptachlor	0.013	0.013
Lindane	0.02	0.04
Methoxychlor	0.8	8
Simazine	0.8	8
Toxaphene	0.33	0.6
Total Petroleum Hydrocarbon by EPA Method 418.1 (This method shall not be used for the analysis of samples collected after June 30, 2009)	500	2,500
Extractable Total Petroleum Hydrocarbons by ETPH Analysis	500	2,500

Substances	GA Area PMC by TCLP or by SPLP in mg/L (ppm)	GB Area PMC by TCLP or by SPLP in mg/L (ppm)
Inorganic Substances and PCBs		
Antimony	0.006	0.06
Arsenic	0.05	0.5
Barium	1	10.0
Beryllium	0.004	0.04
Cadmium	0.005	0.05
Chromium, total	0.05	0.5
Copper	1.3	13
Cyanide (by SPLP only)	0.2	2
Lead	0.015	0.15
Mercury	0.002	0.02
Nickel	0.1	1.0
Selenium	0.05	0.5
Silver	0.036	0.36
Thallium	0.005	0.05

Regulations of Connecticut State Agencies

Substances	GA Area PMC by TCLP or by SPLP in mg/L (ppm)	GB Area PMC by TCLP or by SPLP in mg/L (ppm)
Vanadium	0.05	0.50
Zinc	5	50
PCBs	0.0005	0.005

Appendix C to the RSRs
Groundwater Protection Criteria

Substance	GWPC in µg/L (ppb)
Volatile Organic Substances	
Acetone	700
Acrylonitrile	0.5
Benzene	1
Bromoform	4
2-Butanone (MEK)	400
Carbon tetrachloride	5
Chlorobenzene	100
Chloroform	6
Dibromochloromethane	0.5
1,2-Dichlorobenzene	600
1,3-Dichlorobenzene	600
1,4-Dichlorobenzene	75
1,1-Dichloroethane	70
1,2-Dichloroethane	1
1,1-Dichloroethylene	7
cis-1,2-Dichloroethylene	70
trans-1,2-Dichloroethylene	100
1,2-Dichloropropane	5
1,3-Dichloropropene	0.5
Ethyl benzene	700
Ethylene dibromide (EDB)	0.05
Methyl-tert-butyl-ether	100
Methyl isobutyl ketone	350
Methylene chloride	5

Regulations of Connecticut State Agencies

Substance	GWPC in µg/L (ppb)
Styrene	100
1,1,1,2-Tetrachloroethane	1
1,1,2,2-Tetrachloroethane	0.5
Tetrachloroethylene	5
Toluene	1,000
1,1,1-Trichloroethane	200
1,1,2-Trichloroethane	5
Trichloroethylene	5
Vinyl chloride	2
Xylenes	530
Semi-volatile Organic Substances	
Acenaphthylene	420
Anthracene	2,000
Benzo(a)anthracene	0.06
Benzo(b)fluoranthene	0.08
Benzo(k)fluoranthene	0.5
Benzo(a)pyrene	0.2
Bis(2-chloroethyl)ether	12
Bis(2-chloroisopropyl)ether	12
Bis(2-ethyl hexyl)phthalate	2
Butyl benzl phthalate	1,000
2-chlorophenol	36
Di-n-butyl phthalate	700
Di-n-octyl phthalate	100
2,4-Dichlorophenol	20
Fluoranthene	280
Fluorene	280
Hexachloroethane	3
Hexachlorobenzene	1
Naphthalene	280
Pentachlorophenol	1
Phenanthrene	200
Phenol	4,000

Regulations of Connecticut State Agencies

Substance	GWPC in µg/L (ppb)
Pyrene	200
Inorganic Substances	
Antimony	6
Arsenic	50
Asbestos (in mfl)	7
Barium	1,000
Beryllium	4
Cadmium	5
Chromium (total)	50
Copper	1,300
Cyanide	200
Lead	15
Mercury	2
Nickel	100
Selenium	50
Silver	36
Thallium	5
Vanadium	50
Zinc	5,000
Pesticides, PCBs and Extractable Total Petroleum Hydrocarbons	
Alachlor	2
Aldicarb	3
Atrazine	3
Chlordane	0.3
Dieldrin	0.002
2-4 D	70
Heptachlor epoxide	0.2
Heptachlor	0.4
Lindane	0.2
Methoxychlor	40
Simazine	4
Toxaphene	3
PCB's	0.5

Regulations of Connecticut State Agencies

Substance	GWPC in µg/L (ppb)
Total Petroleum Hydrocarbon by EPA Method 418.1 (This method shall not be used for the analysis of samples collected after June 30, 2009)	500
Extractable Total Petroleum Hydrocarbons by ETPH Analysis	250

Appendix D to the RSRs

Surface Water Protection Criteria for Substances in Groundwater

Substance	SWPC in µg/L(ppb)
Volatile Organic Substances	
Acrylonitrile	20
Benzene	710
Bromoform	10,800
Carbon tetrachloride	132
Chlorobenzene	420,000
Chloroform	14,100
Dibromochloromethane	1,020
1,2-Dichlorobenzene	170,000
1,3-Dichlorobenzene	26,000
1,4-Dichlorobenzene	26,000
1,2-Dichloroethane	2,970
1,1-Dichloroethylene	96
1,3-Dichloropropene	34,000
Ethylbenzene	580,000
Methylene chloride	48,000
1,1,2,2-Tetrachloroethane	110
Tetrachloroethylene	88
Toluene	4,000,000
1,1,1-Trichloroethane	62,000
1,1,2-Trichloroethane	1,260
Trichloroethylene	2,340
Vinyl chloride	15,750
Semi-volatile Organic Substances	
Acenaphthylene	0.3

Regulations of Connecticut State Agencies

Substance	SWPC in µg/L(ppb)
Anthracene	1,100,000
Benzo(a)anthracene	0.3
Benzo(b)fluoranthene	0.3
Benzo(k)fluoranthene	0.3
Benzo(a)pyrene	0.3
Bis(2-chloroethyl) ether	42
Bis(2-chloroisopropyl) ether	3,400,000
Bis(2-ethyl hexyl)phthalate	59
Di-n-butyl phthalate	120,000
2,4-Dichlorophenol	15,800
Fluoranthene	3,700
Fluorene	140,000
Hexachloroethane	89
Hexachlorobenzene	0.077
Phenanthrene	14
Phenol	9,200,0000
Pyrene	110,000
Inorganic Substances	
Antimony	86,000
Arsenic	4
Asbestos (in mfl)	7
Beryllium	4
Cadmium	6
Chromium, trivalent	1,200
Chromium, hexavalent	110
Copper	48
Cyanide	52
Lead	13
Mercury	0.4
Nickel	880
Selenium	50
Silver	12
Thallium	63

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Substance	SWPC in µg/L(ppb)
Zinc	123
Pesticides and PCBs	
Chlordane	0.3
Dieldrin	0.1
Endrin	0.1
Heptachlor epoxide	0.05
Heptachlor	0.05
Toxaphene	1
PCBs	0.5

Appendix E to the RSRs

Volatilization Criteria for Groundwater

Volatile Substance	Residential Volatilization Criteria for Groundwater in µg/L (ppb)	Industrial/Commercial Volatilization Criteria for Groundwater in µg/L (ppb)
Acetone	50,000	50,000
Benzene	215	530
Bromoform	75	2,300
2-Butanone (MEK)	50,000	50,000
Carbon Tetrachloride	5.3	14
Chlorobenzene	1,800	23,000
Chloroform	26	62
1,2-Dichlorobenzene	5,100	50,000
1,3-Dichlorobenzene	4,300	50,000
1,4-Dichlorobenzene	1,400	3,400
1,1-Dichloroethane	3,000	41,000
1,2-Dichloroethane	6.5	68
1,1-Dichloroethylene	190	920
1,2-Dichloropropane	7.4	58
1,3-Dichloropropene	11	360
Ethyl benzene	50,000	50,000
Ethylene dibromide (EDB)	0.30	11
Methyl-tert-butyl-ether	50,000	50,000

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Volatile Substance	Residential Volatilization Criteria for Groundwater in µg/L (ppb)	Industrial/Commercial Volatilization Criteria for Groundwater in µg/L (ppb)
Methyl isobutyl ketone	13,000	50,000
Methylene chloride	160	2,200
Styrene	3,100	42,000
1,1,1,2-Tetrachloroethane	2	64
1,1,2,2-Tetrachloroethane	1.8	54
Tetrachloroethylene	340	810
Toluene	23,500	50,000
1,1,1-Trichloroethane	650	16,000
1,1,2-Trichloroethane	220	2,900
Trichloroethylene	27	67
Vinyl chloride	1.6	52
Xylenes	21,300	50,000

Appendix F to the RSRs

Volatilization Criteria for Soil Vapor

Volatile Substance	Residential Volatilization Criteria for Soil Vapor in parts per million by volume (ppmv)	Residential Volatilization Criteria for Soil Vapor in milligrams per cubic meter (mg/m³)	Industrial/Commercial Volatilization Criteria for Soil Vapor in parts per million by volume (ppmv)	Industrial/Commercial Volatilization Criteria for Soil Vapor in milligrams per cubic meter (mg/m³)
Acetone	57	140	290	690
Benzene	0.78	2.5	1.4	4.6
Bromoform	0.04	0.42	0.98	10
2-Butanone (MEK)	130	376	230	690
Carbon Tetrachloride	0.06	0.38	0.12	0.75
Chlorobenzene	6.1	28	60	280
Chloroform	0.078	0.38	0.14	0.69
1,2-Dichlorobenzene	9.2	55	95	570

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Volatile Substance	Residential Volatilization Criteria for Soil Vapor in parts per million by volume (ppmv)	Residential Volatilization Criteria for Soil Vapor in milligrams per cubic meter (mg/m³)	Industrial/ Commercial Volatilization Criteria for Soil Vapor in parts per million by volume (ppmv)	Industrial/ Commercial Volatilization Criteria for Soil Vapor in milligrams per cubic meter (mg/m³)
1,3-Dichlorobenzene	9.2	55	95	570
1,4-Dichlorobenzene	3	18	5.5	33
1,1-Dichloroethane	14	58	150	600
1,2-Dichloroethane	0.013	0.053	0.11	0.43
1,1-Dichloroethylene	1.9	7.6	7	28
1,2-Dichloropropane	0.021	0.098	0.13	0.58
1,3-Dichloropropene	0.035	0.16	0.89	4.0
Ethyl benzene	9.3	40	93	400
Ethylene dibromide (EDB)	0.0005	0.0056	0.007	0.053
Methyl-tert-butyl-ether	34	120	73	260
Methyl isobutyl ketone	6.8	28	68	280
Methylene chloride	0.65	2.3	6.8	24
Styrene	9.3	39	95	400
1,1,1,2-Tetrachloroethane	0.009	0.062	0.22	1.5
1,1,2,2-Tetrachloroethane	0.0012	0.0083	0.028	0.19
Tetrachloroethylene	0.56	3.8	1	6.9
Toluene	42	160	180	690
1,1,1-Trichloroethane	70	380	130	690
1,1,2-	0.31	1.7	3.1	17

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Volatile Substance	Residential Volatilization Criteria for Soil Vapor in parts per million by volume (ppmv)	Residential Volatilization Criteria for Soil Vapor in milligrams per cubic meter (mg/m³)	Industrial/ Commercial Volatilization Criteria for Soil Vapor in parts per million by volume (ppmv)	Industrial/ Commercial Volatilization Criteria for Soil Vapor in milligrams per cubic meter (mg/m³)
Trichloroethane				
Trichloroethylene	0.14	0.76	0.26	1.4
Vinyl chloride	0.041	0.11	1	2.6
Xylenes	38	170	160	690

Appendix G to the RSRs

Equations, Terms, and Values for Calculating Release-Specific Direct Exposure Criteria, Pollutant Mobility Criteria, Groundwater Protection Criteria, Surface Water Protection Criteria, and Volatilization Criteria, for Additional Polluting Substances and Alternative Volatilization Criteria.

(1) Direct Exposure Criteria for Additional Polluting Substances

(A) Residential Direct Exposure Criteria shall be calculated using the following equations:

(i) For carcinogenic substances:

$$RDEC_{RB} = \left(\frac{RL}{CSF} \right) \div \left[\left(\frac{IR_{child} \times ED_{child} \times EF \times CF}{BW_{child} \times AT_c} \right) + \left(\frac{IR_{adult} \times ED_{adult} \times EF \times CF}{BW_{adult} \times AT_c} \right) \right]$$

(ii) For non-carcinogenic substances:

$$RDEC_{RB} = (RfD \times HI) \div \left[\left(\frac{IR_{child} \times ED_{child} \times EF \times CF}{BW_{child} \times AT_{child}} \right) + \left(\frac{IR_{adult} \times ED_{adult} \times EF \times CF}{BW_{adult} \times AT_{adult}} \right) \right]$$

(iii) The abbreviations in clauses (i) and (ii) of this subparagraph shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

Terms	Description	Value	Units
AT _c	Averaging Time – carcinogens	25,550	days
AT _{adult}	Averaging Time – adult non-carcinogen	8,760	days
AT _{child}	Averaging Time – child non-carcinogen	2,190	days
BW _{adult}	Body Weight – adult	70	kg
BW _{child}	Body Weight – child	15	kg
CF	Conversion Factor	0.000001	kg/mg

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Terms	Description	Value	Units
CSF	Cancer Slope Factor	Substance-specific	(mg/kg-day) ⁻¹
RDEC _{RB}	Residential Risk-based Direct Exposure Criterion	calculated	mg/kg
ED _{adult}	Exposure Duration – adult non-carcinogen	24	years
ED _{child}	Exposure Duration – child non-carcinogen	6	years
EF	Exposure Frequency	365	days/year
HI	Hazard Index	1.0	unitless
IR _{adult}	Ingestion Rate – adult	100	mg/day
IR _{child}	Ingestion Rate – child	200	mg/day
RfD	Reference Dose	Substance-specific	mg/kg-day
RL	Target Cancer Risk Level	1.0E-06	unitless

(iv) If the residential Direct Exposure Criteria calculated pursuant to this subparagraph exceeds the following ceiling values, the ceiling value shall be used in lieu of the calculated value:

Volatile Organic Substances	Semi-volatile Organic Substances	Pesticides, PCBs and ETPH	Inorganic Substances	Units
500	1,000	500	50,000	mg/kg

(v) The residential direct exposure criteria may be adjusted up to the laboratory reporting limit if the commissioner determines that the calculated residential risk-based direct exposure criteria is less than the laboratory reporting limit for such substance.

(B) Industrial/commercial Direct Exposure Criteria shall be calculated using the following equations:

(i) For carcinogenic substances:

$$I/C \text{ DEC}_{RB} = \left(\frac{RL}{CSF} \right) \times \left(\frac{BW \times AT_c}{IR \times ED \times EF \times CF} \right)$$

(ii) For non-carcinogenic substances:

$$I/C \text{ DEC}_{RB} = \left(\frac{RfD \times HI \times BW \times AT}{IR \times ED \times EF \times CF} \right)$$

(iii) The abbreviations in clauses (i) and (ii) of this subparagraph shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

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Terms	Description	Value	Units
AT _c	Averaging Time – carcinogens	25,550	days
AT	Averaging Time – non-carcinogen	9,125	days
BW	Body Weight – adult	70	kg
CF	Conversion Factor	0.000001	kg/mg
CSF	Cancer Slope Factor	substance-specific	(mg/kg-day) ⁻¹
I/CDEC _{RB}	Industrial/Commercial Risk-based Direct Exposure Criterion	calculated	mg/kg
ED	Exposure Duration	25	years
EF	Exposure Frequency	250	days/year
HI	Hazard Index	1.0	unitless
IR	Ingestion Rate	50	mg/day
RfD	Reference Dose	substance-specific	mg/kg-day
RL	Target Cancer Risk Level	1.0E-06	unitless

(iv) If the industrial/commercial direct exposure criteria calculated pursuant to this subparagraph exceeds the following ceiling values, the ceiling value shall be used in lieu of the calculated value:

Volatile Organic Substances	Semi-volatile Organic Substances	Pesticides, PCBs and ETPH	Inorganic Substances	Units
1,000	2,500	1,000	50,000	mg/kg

(v) The industrial/commercial direct exposure criteria may be adjusted up to the laboratory reporting limit if the commissioner determines that the calculated industrial/commercial risk-based direct exposure criteria is less than the laboratory reporting limit for such substance.

(2) Pollutant Mobility Criteria for Additional Polluting Substances

(A) Pollutant Mobility Criteria for inorganic substances shall be calculated using the following equations:

(i) For GA area groundwater classification:

$$PMC_{mg/L} = GWPC \times CF$$

(ii) For GB area groundwater classification:

$$PMC_{mg/L} = GWPC \times CF \times DF$$

(B) Pollutant Mobility Criteria for organic substances shall be calculated using the

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following equations:

(i) For GA area groundwater classification:

$$PMC_{\text{mg/kg}} = \text{GWPC} \times \text{CF} \times \text{AAF}$$

(ii) For GB area groundwater classification:

$$PMC_{\text{mg/kg}} = \text{GWPC} \times \text{CF} \times \text{AAF} \times \text{DF}$$

(C) The abbreviations in subparagraphs (A) and (B) of this subdivision shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

Terms	Description	Value	Units
AAF	Analytical Adjustment Factors	20	unitless
CF	Conversion Factor	0.001	mg/μg
DF	Dilution Factor	10	unitless
GWPC	Groundwater Protection Criteria	substance-specific	μg/L
PMC	Pollutant Mobility Criteria	calculated	mg/kg or mg/L

(3) Groundwater Protection Criteria for Additional Polluting Substances

(A) Groundwater Protection Criteria shall be calculated for carcinogenic substances using the following equation:

$$\text{GWPC} = \left(\frac{\text{RL}}{\text{CSF}} \right) \times \left(\frac{\text{BW} \times \text{AT}}{\text{IR} \times \text{EF} \times \text{ED} \times \text{CF}} \right)$$

(B) Groundwater Protection Criteria shall be calculated for non-carcinogenic substances using the following equation:

$$\text{GWPC} = \frac{\text{RfD} \times \text{HI} \times \text{BW} \times \text{AT} \times \text{SA}}{\text{IR} \times \text{EF} \times \text{ED} \times \text{CF}}$$

(C) The abbreviations in subparagraphs (A) and (B) of this subdivision shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

Terms	Description	Value	Units
AT	Averaging Time	25,550	days
BW	Body Weight	70	kg
CSF	Cancer Slope Factor	substance-specific	(mg/kg-day) ⁻¹
CF	Conversion Factor	0.001	mg/μg
ED	Exposure Duration	70	years

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Terms	Description	Value	Units
EF	Exposure Frequency	365	days/year
GWPC	Risk-based Groundwater Protection Criterion	calculated	µg/L
HI	Hazard Index	1.0	unitless
IR	Ingestion Rate	2	L/day
RfD	Reference Dose	substance-specific	mg/kg-day
RL	Target Cancer Risk Level	1.0E-06	unitless
SA	Source Allocation	0.2	unitless

(D) If the Groundwater Protection Criteria calculated pursuant to subparagraph (A) or (B) of this subdivision exceeds the following ceiling values, the ceiling value shall be used in lieu of the calculated value:

Volatile Organic Substances	Semi-volatile Organic Substances	Pesticides, PCBs, and ETPH	Inorganic Substances	Units
1,000	1,000	1,000	1,000	µg/L

(E) The groundwater protection criteria may be adjusted up to the laboratory reporting limit if the commissioner determines that the calculated risk-based groundwater protection criteria is less than the laboratory reporting limit for such substance.

(F) The groundwater protection criteria may be adjusted down to the organoleptic threshold if the commissioner determines that the calculated risk-based groundwater protection criteria is higher than the organoleptic threshold for such substance.

(4) Surface Water Protection Criteria for Additional Polluting Substances

(A) Determining Water Quality Criteria

For substances that have no water quality criteria in the water quality standards, such criteria shall be determined using EPA's national recommended water quality criteria and, if no such criteria are available, then by using the following:

(i) Determining the Water Quality Criteria for Chronic Aquatic Life

(I) In accordance with title 40 CFR 132 Appendix A (Great Lakes Water Quality Initiative Methodologies for Development of Aquatic Life Criteria and Values);

(II) Using the Tier 1 protocols for calculating a Criterion Continuous Concentration; or

(III) If insufficient information is available to use the Tier 1 Criterion Continuous Concentration procedure, using the Tier 2 protocols for calculating a Secondary Continuous Concentration.

(ii) Calculating the Water Quality Criteria for Human Health for Fish Consumption:

(I) For carcinogenic substances:

$$WQC = \frac{RL \times BW \times CF}{CSF \times FC \times BAF}$$

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(II) For non-carcinogenic substances:

$$WQC = \frac{RfD \times BW \times CF \times RSC}{FC \times BAF}$$

(III) The abbreviations in subclauses (I) and (II) of this clause shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

Terms	Description	Value	Units
BAF	Bioaccumulation Factor	substance-specific	unitless
BW	Body Weight	70	kg
CF	Conversion Factor	1,000	µg/mg
CSF	Cancer Slope Factor	substance-specific	(mg/kg-day) ⁻¹
FC	Fish Consumption Rate	0.0175	kg/d
RfD	Reference Dose	substance-specific	mg/kg-day
RL	Risk Level	1.00E-06	unitless
WQC	Water Quality Criteria	substance-specific	µg/L
RSC	Relative Source Contribution	0.2	unitless

(B) Calculating the Surface Water Protection Criteria

The risk-based surface water protection criteria shall be calculated, for the lower of aquatic life or human health water quality criteria:

(i) Water quality criteria for freshwater chronic aquatic life protection as determined using subparagraph (A) of this subdivision, multiplied by ten (10); or

(ii) Water quality criteria for human health for fish consumption calculated using subparagraph (A) of this subdivision, multiplied by the applicable flow factor multiplied by ten (10), using the following values:

Flow Factor	Substance Risk Level
1	For known human carcinogens or substances which may bioaccumulate BCF > 100
2	For non-carcinogenic substances
3	For carcinogenic substances

(C) If the Surface Water Protection Criteria calculated pursuant to subparagraph (B) of this subdivision exceeds the following ceiling values, the ceiling value shall be used in lieu of the calculated value:

Volatile Substances	Semi-volatile Organic Substances	Pesticides, PCBs and ETPH	Inorganic Substances	Units
10,000	10,000	10,000	10,000	µg/L

(D) The surface water protection criteria may be adjusted up to the laboratory reporting

limit if the commissioner determines that the calculated risk-based surface water protection criteria is less than the laboratory reporting limit for such substance.

(5) Volatilization Criteria for Additional Polluting Substances

(A) Residential Target Indoor Air Concentrations shall be calculated using the following equations:

(i) For carcinogenic substances:

$$TAC = \frac{RL \times BW \times AT_c \times CF}{CSF_i \times CexpF \times CsensF \times IR_{air} \times EF \times ED}$$

(ii) For non-carcinogenic substances:

$$TAC = \frac{HQ \times BW \times RfD_i \times AT \times CF}{CexpF \times IR_{air} \times EF \times ED}$$

(iii) The abbreviations in this subparagraph shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

Terms	Description	Value	Units
AT	Averaging Time – non-carcinogen	10,950	days
AT _c	Averaging Time – carcinogen	25,550	days
BW	Body Weight	70	kg
CexpF	Children’s Exposure Factor	2	unitless
CF	Conversion Factor	1,000	µg/mg
CsensF	Children’s Sensitivity Factor CsensF = 1 for non-carcinogens and non-mutagenic carcinogens. CsensF = 2 for mutagenic carcinogens	substance-specific	unitless
CSF _i	Cancer Slope Factor – Inhalation	substance-specific	(mg/kg-day) ⁻¹
ED	Exposure Duration	30	years
EF	Exposure Frequency	350	days/year
HQ	Hazard Quotient	1	unitless
IR _{air}	Inhalation Rate – air	20	m ³ /day
RfD _i	Reference Dose – inhalation	substance-specific	mg/m ³
RL	Risk Level	1.00E-06	unitless
TAC	Target Indoor Air Concentration	substance-specific	µg/m ³

(iv) If the residential Target Indoor Air Concentration calculated pursuant to clause (i)

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or (ii) of this subparagraph exceeds a ceiling value of 500 µg/m³, the ceiling value shall be used in lieu of the calculated value.

(B) Industrial/Commercial Target Indoor Air Concentrations shall be calculated using the following equations:

(i) For carcinogenic substances:

$$TAC = \frac{RL \times BW \times AT_c \times CF}{CSF_i \times IR_{air} \times EF \times ED}$$

(ii) For non-carcinogenic substances:

$$TAC = \frac{HQ \times BW \times RfD_i \times AT \times CF}{IR_{air} \times EF \times ED}$$

(iii) The abbreviations used in this subparagraph shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

Terms	Description	Value	Units
AT	Averaging Time – non-carcinogen	9,125	days
AT _c	Averaging Time – carcinogen	25,550	days
BW	Body Weight	70	kg
CF	Conversion Factor	1,000	µg/mg
CSF _i	Cancer Slope Factor – inhalation	substance-specific	(mg/kg-day) ⁻¹
ED	Exposure Duration	25	years
EF	Exposure Frequency	250	days/year
HQ	Hazard Quotient	1	unitless
IR _{air}	Inhalation Rate – air	10	m ³ /day
RfD _i	Reference Dose – inhalation	substance-specific	mg/m ³
RL	Risk Level	1.00E-06	unitless
TAC	Target Indoor Air Concentration	substance-specific	µg/m ³

(iv) If the industrial/commercial Target Indoor Air Concentration calculated pursuant to clause (i) or (ii) of this subparagraph exceeds a ceiling value of five hundred (500) µg/m³, the ceiling value shall be used in lieu of the calculated value.

(C) Volatilization Protection Criterion shall be calculated using the following equations:

(i) For Volatilization Criteria for Groundwater:

$$GWVC = \frac{TAC}{CF \times \alpha \times H}$$

(ii) If the groundwater volatilization criteria calculated pursuant to clause (i) of this subparagraph exceeds a ceiling value of fifty thousand (50,000) $\mu\text{g/L}$, the ceiling value shall be used in lieu of the calculated value.

(iii) For Volatilization Criteria for Soil Vapor:

$$\text{SVVC}_{\text{mg/m}^3} = \frac{\text{TAC}}{\text{CF} \times \alpha}$$

$$\text{SVVC}_{\text{ppmv}} = \text{SVVC}_{\text{mg/m}^3} \times \left(\frac{\text{MV}}{\text{MW}} \right)$$

(iv) The attenuation factor for diffusion and advection (α) shall be calculated using the following equations:

$$\alpha = \frac{A \times e^B}{e^B + A + (A/C) \times (e^B - 1)}$$

$$A = \frac{D_{\text{T}}^{\text{eff}} \times A_{\text{B}}}{Q_{\text{B}} \times L_{\text{T}}} \quad \text{or} \quad A = \frac{D_{\text{T}}^{\text{eff}}}{E_{\text{B}} \times (V_{\text{B}}/A_{\text{B}}) \times L_{\text{T}}}$$

$$B = \frac{Q_{\text{soil}} \times L_{\text{crack}}}{D_{\text{crack}}^{\text{eff}} \times \eta \times A_{\text{B}}} \quad \text{or} \quad B = \left(\left(\frac{Q_{\text{soil}}}{Q_{\text{B}}} \right) \times E_{\text{B}} \times \left(\frac{V_{\text{B}}}{A_{\text{B}}} \right) \times L_{\text{crack}} \right) / (D_{\text{crack}}^{\text{eff}} \times \eta)$$

$$C = \frac{Q_{\text{soil}}}{Q_{\text{B}}}$$

$$D_{\text{T}}^{\text{eff}} = \frac{L_{\text{T}}}{(L_{\text{vadose}}/D_{\text{vadose}}^{\text{eff}}) + (L_{\text{cap}}/D_{\text{cap}}^{\text{eff}})}$$

$$D_{\text{crack}}^{\text{eff}} = D^{\text{air}} \times \left(\frac{\theta_{\text{V-crack}}^{3.33}}{\theta_{\text{T-crack}}^2} \right) + \left(\frac{D^{\text{water}}}{H} \right) \times \left(\frac{\theta_{\text{m-crack}}^{3.33}}{\theta_{\text{T-crack}}^2} \right)$$

$$D_{\text{vadose}}^{\text{eff}} = D^{\text{air}} \times \left(\frac{\theta_{\text{V-vadose}}^{3.33}}{\theta_{\text{T-vadose}}^2} \right) + \left(\frac{D^{\text{water}}}{H} \right) \times \left(\frac{\theta_{\text{m-vadose}}^{3.33}}{\theta_{\text{T-vadose}}^2} \right)$$

$$D_{\text{cap}}^{\text{eff}} = D^{\text{air}} \times \left(\frac{\theta_{\text{V-cap}}^{3.33}}{\theta_{\text{T-cap}}^2} \right) + \left(\frac{D^{\text{water}}}{H} \right) \times \left(\frac{\theta_{\text{m-cap}}^{3.33}}{\theta_{\text{T-cap}}^2} \right)$$

(v) The abbreviations used in this subparagraph shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

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Terms	Description	Value	Units
α	Attenuation Factor for Diffusion and Advection	calculated	unitless
A_B	Surface Area of the Enclosed Space in Contact with Soil	site-specific	m ²
CF	Conversion Factor	1,000	L/m ³ or $\mu\text{g}/\text{mg}$
D^{air}	Molecular Diffusion Coefficient in Air	substance-specific	m ² /d
D^{eff}_T	Total Effective Diffusion	calculated	cm ² /s
$D^{\text{eff}}_{\text{crack}}$	Effective Diffusion Through Foundation Cracks	calculated	cm ² /s
$D^{\text{eff}}_{\text{cap}}$	Effective Diffusion Through Capillary Fringe	calculated	cm ² /s
$D^{\text{eff}}_{\text{vadose}}$	Effective Diffusion Through Vadose Zone	calculated	cm ² /s
D^{water}	Molecular Diffusion Coefficient in Water	substance-specific	m ² /d
$D^{\text{water}}/D^{\text{air}}$	Ratio of Molecular Diffusion in Water to Air = $D^{\text{water}}/D^{\text{air}}$	calculated	unitless
E_B	Enclosed Space Air Exchange Rate	site-specific	1/day
GWVC	Groundwater Volatilization Criteria	calculated	$\mu\text{g}/\text{L}$
H	Henry's Law Constant	substance-specific	unitless
k	Soil Vapor Permeability	site-specific	cm ²
L_T	Depth from foundation to source	site-specific	m
L_{cap}	Thickness of Capillary Fringe	site-specific	m
L_{crack}	Foundation Thickness	site-specific	m
L_{vadose}	Thickness of Vadose Zone = $L_T - L_{\text{cap}}$	calculated	m
MV	Molar Volume (at standard conditions)	24.45	L
MW	Molecular Weight	substance-specific	g/mol
η	Fraction of Enclosed Space Area Open for Vapor Intrusion	site-specific	m ² /d
$\theta_{\text{m-cap}}$	Volumetric Moisture Content in Cracks in Capillary Fringe	site-specific	unitless

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Terms	Description	Value	Units
$\theta_{T\text{-cap}}$	Total Porosity in Capillary Fringe	site-specific	unitless
$\theta_{V\text{-cap}}$	Volumetric Vapor Constant in Capillary Fringe = $\theta_{T\text{-cap}} - \theta_{m\text{-cap}}$	calculated	unitless
$\theta_{m\text{-crack}}$	Volumetric Moisture Content in Cracks	site-specific	unitless
$\theta_{T\text{-crack}}$	Total Porosity in Crack	site-specific	unitless
$\theta_{V\text{-crack}}$	Volumetric Vapor Content in Cracks = $\theta_{T\text{-crack}} - \theta_{m\text{-crack}}$	calculated	unitless
$\theta_{m\text{-vadose}}$	Volumetric Moisture Content in Vadose Zone	site-specific	unitless
$\theta_{T\text{-vadose}}$	Total Porosity in Vadose Zone	site-specific	unitless
$\theta_{V\text{-vadose}}$	Volumetric Vapor Content in Vadose Zone = $\theta_{T\text{-vadose}} - \theta_{m\text{-vadose}}$	calculated	unitless
ΔP	Indoor-Outdoor Air Pressure Difference	site-specific	g/ms ²
Q_B	Enclosed Space Volumetric Air Flow Rate = $V_B E_B$	calculated	m ³ /d
Q_{soil}	Pressure Driven Soil Gas Flow Rate from the subsurface into the enclosed space = $(2\pi k \Delta P X_{\text{crack}}) / [\mu \ln(2Z_{\text{crack}}/R_{\text{crack}})]$	calculated	m ³ /d
Q_{soil}/Q_B	Ratio of Soil Gas Intrusion Rate to Building Ventilation Rate = Q_{soil}/Q_B	calculated	unitless
R_{crack}	Effective Crack Radius or Width = $\eta A_B / X_{\text{crack}}$	calculated	m
SVVC	Soil Vapor Volatilization Criteria	calculated	mg/m ³
TAC	Target Indoor Air Concentration calculated using subparagraph (A) or (B), as applicable	substance-specific	μg/m ³
μ	Viscosity of Air	substance-specific	g/ms
VB	Enclosed Space Volume	site-specific	m ³
V_B/V_A	Ratio of Enclosed Space Volume to Exposed Surface Area = V_B/V_A	calculated	m
X_{crack}	Total Length of Cracks through which Soil	site-specific	m

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Terms	Description	Value	Units
	Gas Vapors are Flowing		
Z _{crack}	Crack Opening Depth Below Grade	site-specific	m

Appendix H to the RSRs

Equations, Terms, and Values for Calculating Release-Specific Alternative Pollutant Mobility Criteria

(1) Release-Specific Pollutant Mobility Criteria shall be calculated using the following equation:

$$\text{Alt PMC} = \text{GWC} \times \text{DF} \left(K_d + \frac{(\theta_w + \theta_a H')}{\rho_b} \right)$$

(2) The abbreviations in subdivision (1) of Appendix H of the RSRs, shall be interpreted in accordance with the following table and shall be assigned the values specified therein:

Terms	Description	Value	Units
Alt PMC	Alternative Pollutant Mobility Criteria	calculated	mg/kg
GWC	Groundwater Criteria Goal	substance-specific (lowest of groundwater criteria applicable to release area)	mg/L
DF	Dilution Factor	20 or calculated in accordance with section 22a-133k-2(c)(2)(E)(ii) of the RSRs with F _{adj} = 0	unitless
K _d	Distribution Coefficient for Organic Contaminants may be approximated by: K _{oc} * f _{oc}	substance-specific (see table below for inorganic substances)	L/kg
K _{oc}	Soil Organic Carbon-water Partition Coefficient	substance-specific (see table below for organic substances)	L/kg
f _{oc}	Soil Fraction of Organic Carbon	0.001 or tested for site-specific value (max value = 0.006)	kg/kg

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Terms	Description	Value	Units
θ_w	Water-filled Soil Porosity	0.28	$L_{\text{water}}/L_{\text{soil}}$
θ_a	Air-filled Soil Porosity	0.15	$L_{\text{air}}/L_{\text{soil}}$
H'	Henry's Law Constant	substance-specific (see tables below)	unitless
ρ_b	Dry Soil Bulk Density	1.5	kg/L

Soil Organic Carbon-Water Partition Coefficient (K_{oc}) and Henry's Law Constant (H')
Values for Organic Substances

Substance	K_{oc} (L/kg)	H' (Dimensionless)
Acenaphthylene	6,800	4.51E-03
Acetone	0.575	1.75E-03
Acrylonitrile	2	4.10E-03
Alachlor	310	4.30E-07
Aldicarb	24.6	5.89E-08
Anthracene	23,500	2.67E-03
Atrazine	360	1.21E-07
Benzene	62	2.26E-01
Benzo(a)anthracene	358,000	1.37E-04
Benzo(a)pyrene	969,000	4.63E-05
Benzo(b)fluoranthene	1,230,000	4.55E-03
Benzo(k)fluoranthene	1,230,000	3.40E-05
Bis(2-chloroethyl)ether	76	7.38E-04
Bis(2-chloroisopropyl)ether	360	3.03E-03
Bis(2-ethylhexyl)phthalate	111,000	4.18E-06
Bromoform	126	2.18E-02
2-Butanone (MEK)	10	1.12E-03
Butyl benzyl phthalate	13,700	5.17E-05
Carbon tetrachloride	152	1.20E+00
Chlordane	51,300	1.99E-03
Chlorobenzene	224	1.61E-01
Chloroform	53	1.39E-01
2-Chlorophenol	398	1.60E-02

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Substance	K_{oc} (L/kg)	H' (Dimensionless)
Dibromochloromethane (Chlorodibromomethane)	63.1	3.21E-02
1,2-Dichlorobenzene (<i>o</i>)	379	7.95E-02
1,3-Dichlorobenzene (<i>m</i>)	700	1.08E-01
1,4-Dichlorobenzene (<i>p</i>)	616	1.12E-01
1,1-Dichloroethane	53	2.23E-01
1,2-Dichloroethane	38	4.51E-02
1,1-Dichloroethylene	65	6.11E-01
<i>cis</i> -1,2-Dichloroethylene	35.5	1.70E-01
<i>trans</i> -1,2-Dichloroethylene	38	3.80E-01
2,4-Dichlorophenol	159	1.30E-04
2,4-Dichlorophenoxyacetic acid (2,4-D)	29.6	1.45E-06
1,2-Dichloropropane	47	1.16E-01
1,3-Dichloropropene	27	1.44E-01
Dieldrin	25,500	6.19E-04
Di- <i>n</i> -butyl phthalate	1,570	3.85E-08
Di- <i>n</i> -octyl phthalate	140,000	2.74E-03
Ethylbenzene	204	1.41E-01
Ethylene dibromide (EDB)	66	2.76E-02
Fluoranthene	49,100	6.60E-04
Fluorene	7,710	2.61E-03
Heptachlor	9,530	4.47E-02
Heptachlor epoxide	83,200	3.90E-04
Hexachlorobenzene	80,000	5.41E-02
g-HCH (Lindane)	1,350	5.74E-04
Hexachloroethane	1,780	1.59E-01
Methoxychlor	80,000	6.48E-04
Methyl isobutyl ketone	65	5.33E-03
Methyl- <i>tert</i> -butyl-ether (MTBE)	34	2.42E-02
Methylene chloride	10	1.31E-01
Naphthalene	1,190	1.98E-02
Pentachlorobenzene	32,100	2.87E-02
Pentachlorophenol	7,960	1.00E-06

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Substance	K_{oc} (L/kg)	H' (Dimensionless)
Phenanthrene	21,200	9.43E-04
Phenol	28.8	1.63E-05
Pyrene	68,000	4.51E-04
Simazine	147	3.85E-08
Styrene	912	1.07E-01
1,1,1,2-Tetrachloroethane	86	4.51E-01
1,1,2,2-Tetrachloroethane	79	1.56E-02
Tetrachloroethylene	265	8.36E-02
Toluene	140	2.74E-01
Toxaphene	95,800	2.46E-04
1,1,1-Trichloroethane	135	9.47E-01
1,1,2-Trichloroethane	75	3.73E-02
Trichloroethylene	94	3.74E-01
Vinyl chloride	18.6	1.14E+00
Xylenes	1,700	2.16E-01

Distribution Coefficient (K_d) and Henry's Law Constant (H') Values for Inorganic Substances

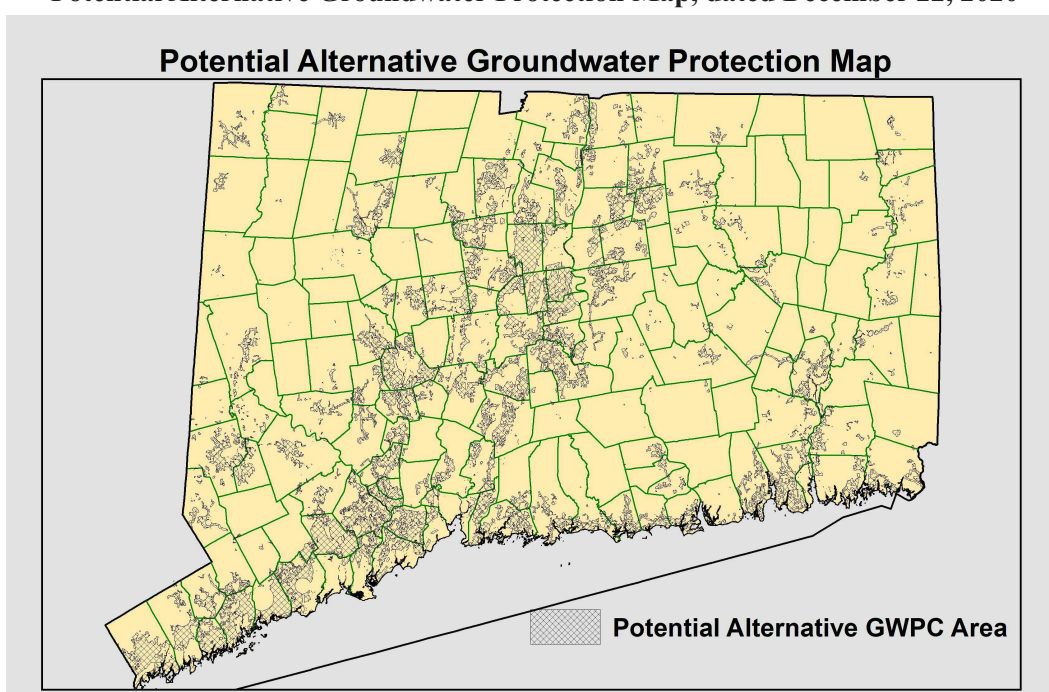
Substance	K_d (L/kg)	H' (Dimensionless)
Antimony	45	-
Arsenic	25	-
Barium	12	-
Beryllium	26	-
Cadmium	17	-
Chromium (hexavalent or total)	31	-
Chromium (trivalent only)	1,900	-
Copper	35	-
Cyanide	9.9	-
Lead	900	-
Mercury	0.06	4.67E-01
Nickel	18	-
Silver	0.13	-
Selenium	17	-

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Substance	K_d (L/kg)	H' (Dimensionless)
Thallium	45	-
Vanadium	1,000	-
Zinc	18	-

Appendix I of the RSRs

Potential Alternative Groundwater Protection Map, dated December 22, 2020



The map in this Appendix is for use in accordance with section 22a-133k-3(d)(2) of the RSRs. The department shall make this map, titled “Potential Alternative Groundwater Protection Criteria Map” dated December 22, 2020, as provided in this Appendix, available on the department’s Internet website and shall also make such map available during regular business hours at the Department of Energy and Environmental Protection, Division of Water Protection and Land Reuse, 79 Elm Street, 2nd floor, Hartford, Connecticut.

If a reader is viewing said map in hard copy or on the DEEP website, any such area shaded in the color or using a similar designation is an area where a potential alternative groundwater protection area has been identified. If a reader is viewing such map on the regs system, any area shaded in a cross-hatched pattern is an area where a potential alternative groundwater protection area has been identified.

(Effective January 30, 1996; Amended June 27, 2013; Amended February 16, 2021)