Soil Standard Determination Methods & Processes

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Policy & Technical Resources Chief
Wisconsin DNR
Key Points

- Soil Cleanup Standards (NR 720.10 or NR 720.12) – RCL
- Regional Screening Level - RSL
- Background Threshold Values – BTV
- Averaging – UCL
RR’s Spreadsheet of Soil RCLs

<table>
<thead>
<tr>
<th>Direct-Contact RCLs</th>
<th>Groundwater-Protective RCLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrations from depth of 0 to 4 ft</td>
<td>Concentrations Nearest or At the Water Table</td>
</tr>
</tbody>
</table>

For a complete SI, a separate assessment of groundwater quality (via sampling) is needed.

Available at RR’s “Resources for Environmental Professionals” Webpage

[http://dnr.wi.gov/topic/Brownfields/Professionals.html]
Where did RCLs come from?

- U.S. EPA RSL Web-Calculator
Where did RCLs come from?

BTVs from USGS Report

### Title: Distribution and Variation of Arsenic in Wisconsin Surface Soils, With Data on Other Trace Elements

**Table 1-2.** Statistical summary, including 95-percent upper confidence limit of the mean (95% UCL), of trace elements in Wisconsin. Summaries are for the entire dataset after outliers were removed. (*For the element molybdenum, the p value is less than 0.10 for the censored-data methods that were used in this report. None of the summary statistics were calculated for this element.*)

<table>
<thead>
<tr>
<th>Trace element</th>
<th>Number of samples</th>
<th>Non-detects (%)</th>
<th>Minimum detected value</th>
<th>Maximum detected value</th>
<th>Median</th>
<th>Mean</th>
<th>95% UCL of the mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>662</td>
<td>0</td>
<td>610</td>
<td>28,721</td>
<td>8,282</td>
<td>9,147</td>
<td>9,479</td>
</tr>
<tr>
<td>Arsenic</td>
<td>654</td>
<td>32.3</td>
<td>1.0</td>
<td>8.3</td>
<td>1.8</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Barium</td>
<td>658</td>
<td>0</td>
<td>3.53</td>
<td>364</td>
<td>92.0</td>
<td>101</td>
<td>105</td>
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<tr>
<td>Calcium</td>
<td>607</td>
<td>0</td>
<td>22.9</td>
<td>14,536</td>
<td>1,931</td>
<td>2,831</td>
<td>3,025</td>
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<tr>
<td>Cadmium</td>
<td>642</td>
<td>38</td>
<td>0.10</td>
<td>1.07</td>
<td>0.15</td>
<td>0.23</td>
<td>0.25</td>
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<tr>
<td>Cobalt</td>
<td>661</td>
<td>1.5</td>
<td>0.51</td>
<td>22.0</td>
<td>6.34</td>
<td>6.61</td>
<td>6.87</td>
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<tr>
<td>Chromium</td>
<td>659</td>
<td>0</td>
<td>0.95</td>
<td>43.5</td>
<td>12.5</td>
<td>13.7</td>
<td>14.2</td>
</tr>
</tbody>
</table>
**Direct-Contact RCLs**

If concentration < BTV, direct contact is ignored.

```
<table>
<thead>
<tr>
<th>Contaminant</th>
<th>CAS Number</th>
<th>Non RCL (mg/kg)</th>
<th>G RCL (mg/kg)</th>
<th>Net-To-Exceed DC RCL (mg/kg)</th>
<th>Basis</th>
<th>Background Threshold Value (mg/kg)</th>
<th>INPUT Site Data (mg/kg)</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td>111</td>
<td>1.49</td>
<td>1.45</td>
<td>ca</td>
<td></td>
<td>1.45</td>
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<tr>
<td>Ethylbenzene</td>
<td>100-41-4</td>
<td>4,220</td>
<td>7.47</td>
<td>7.47</td>
<td>ca</td>
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<td>7.47</td>
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<tr>
<td>Toluene</td>
<td>108-88-3</td>
<td>5,390</td>
<td>-</td>
<td>818</td>
<td>Cast</td>
<td></td>
<td>818.00</td>
<td></td>
</tr>
<tr>
<td>Xylenes</td>
<td>1336-20-7</td>
<td>699</td>
<td>-</td>
<td>259</td>
<td>Cast</td>
<td></td>
<td>259.00</td>
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<tr>
<td>Methyl tert-Butyl Ether (MTBE)</td>
<td>1634-04-4</td>
<td>23,899</td>
<td>99.4</td>
<td>99.4</td>
<td>ca</td>
<td></td>
<td>99.4</td>
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<tr>
<td>Dichloromethane, 1,2-</td>
<td>75-08-6</td>
<td>46.7</td>
<td>0.608</td>
<td>0.608</td>
<td>ca</td>
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<td>0.608</td>
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<tr>
<td>Dibromochloromethane</td>
<td>106-93-4</td>
<td>197</td>
<td>0.047</td>
<td>0.047</td>
<td>ca</td>
<td></td>
<td>0.047</td>
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</tr>
<tr>
<td>Trichloroethylene</td>
<td>79-01-6</td>
<td>9.66</td>
<td>1.26</td>
<td>1.26</td>
<td>ca</td>
<td></td>
<td>1.26</td>
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<tr>
<td>Tetrachloroethylene</td>
<td>127-18-4</td>
<td>115</td>
<td>30.7</td>
<td>30.7</td>
<td>ca</td>
<td></td>
<td>30.7</td>
<td></td>
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<tr>
<td>Vinyl Chloride</td>
<td>78-01-4</td>
<td>93.3</td>
<td>0.067</td>
<td>0.067</td>
<td>ca</td>
<td></td>
<td>0.067</td>
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<tr>
<td>Dichloroethylene, 1,1-</td>
<td>76-35-4</td>
<td>342</td>
<td>-</td>
<td>342</td>
<td>nc</td>
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<td>342.00</td>
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<tr>
<td>Dichloroethylene, 1,2-trans-</td>
<td>156-65-5</td>
<td>1,560</td>
<td>-</td>
<td>1,560</td>
<td>nc</td>
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<td>1,560</td>
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<td>Dichloroethylene, 1,2-cis-</td>
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<td>158</td>
<td>-</td>
<td>158</td>
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<td>158.00</td>
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<td>Trichlorobenzene, 1,1,1-</td>
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<td>12,390</td>
<td>649</td>
<td>Cast</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Carbon Tetrachloride</td>
<td>66-23-6</td>
<td>137</td>
<td>0.054</td>
<td>0.054</td>
<td>ca</td>
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<td>0.054</td>
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<tr>
<td>Trichloroethylene, 1,2,4-</td>
<td>75-63-6</td>
<td>89.8</td>
<td>-</td>
<td>89.8</td>
<td>nc</td>
<td></td>
<td>89.8</td>
<td></td>
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<tr>
<td>Trichloroethylene, 1,3,5-</td>
<td>108-67-8</td>
<td>782</td>
<td>-</td>
<td>782</td>
<td>Cast</td>
<td></td>
<td>782.00</td>
<td></td>
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<tr>
<td>Naphthalene</td>
<td>91-20-3</td>
<td>188</td>
<td>5.15</td>
<td>5.15</td>
<td>ca</td>
<td></td>
<td>5.15</td>
<td></td>
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<tr>
<td>Benz[a]pyrene</td>
<td>62-33-8</td>
<td>0.015</td>
<td>-</td>
<td>0.015</td>
<td>ca</td>
<td></td>
<td>0.015</td>
<td></td>
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<tr>
<td>Acenaphthylene</td>
<td>83-32-9</td>
<td>3,440</td>
<td>-</td>
<td>3,440</td>
<td>nc</td>
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<td>3,440</td>
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<tr>
<td>Acenaphthylene</td>
<td>268-98-8</td>
<td>0.014</td>
<td>-</td>
<td>0.014</td>
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<td>0.014</td>
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<tr>
<td>Anthracene</td>
<td>120-13-7</td>
<td>17,200</td>
<td>-</td>
<td>17,200</td>
<td>nc</td>
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<td>17,200</td>
<td></td>
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<tr>
<td>Benz[b]anthracene</td>
<td>56-55-5</td>
<td>0.148</td>
<td>-</td>
<td>0.148</td>
<td>nc</td>
<td></td>
<td>0.148</td>
<td></td>
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<tr>
<td>Benz[a]fluoranthene</td>
<td>265-19-3</td>
<td>0.377</td>
<td>-</td>
<td>0.377</td>
<td>nc</td>
<td></td>
<td>0.377</td>
<td></td>
</tr>
<tr>
<td>Benz[b]pyrene</td>
<td>265-99-2</td>
<td>0.148</td>
<td>-</td>
<td>0.148</td>
<td>nc</td>
<td></td>
<td>0.148</td>
<td></td>
</tr>
<tr>
<td>Benz[a]amylene</td>
<td>101-24-2</td>
<td>0.148</td>
<td>-</td>
<td>0.148</td>
<td>nc</td>
<td></td>
<td>0.148</td>
<td></td>
</tr>
</tbody>
</table>
```

Available at RR’s “Resources for Environmental Professionals” WebPage
http://dnr.wi.gov/topic/Brownfields/Professionals.html
### Soil Data Summary Table

**BRRTS #: 02-73-007107**

**SITE NAME:** Leysamute Inn

**SITE ADDRESS:** Leysamute, WI

<table>
<thead>
<tr>
<th>BORING #</th>
<th>B-1</th>
<th>B-1</th>
<th>B-2</th>
<th>B-3</th>
<th>B-4</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPTH (ft BGS)</td>
<td>2.5 - 4.5</td>
<td>5.7</td>
<td>2.5 - 4.5</td>
<td>5.7</td>
<td>0.4</td>
<td>6.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soil RCLs (mg/kg)</th>
<th>Calculated 06/2014</th>
<th>Background</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Industrial Direct Contact</td>
<td>Soil to GW</td>
<td>Surficial BTV</td>
<td>Detection Limit (mg/kg)</td>
</tr>
</tbody>
</table>

**Soil Concentrations in mg/kg (or ppm):**

- **Benzene:** 0.75, < 0.005, 2, 0.5, 1, 1, 1
- **Ethylbenzene:** 5.6, < 0.005, 2, < 0.005, 1, 1
- **Toluene:** 800, 0.05, 10, 2, < 0.005, 2, 2
- **Xylene:** 250, 0.1, 10, 4, < 0.005, 50, 50
- **PCE:** 1, 0.05, 2, < 0.005, 7, 7
- **Naphthalene:** 1, < 0.005, 2, < 0.005, 3, 3
- **Benzaldehyde:** < 0.01, < 0.01, 0.1, 0.5, 0.4, 0.3, 0.3
- **Arsenic:** 5, < 0.5, 10, 5, < 0.5, 8, 8
- **Lead:** 240, 0.25, 100, 50, < 1, 50, 50

**Detection Limits:**

- 0.005
- 0.005
- 0.005
- 0.005
- 0.01
- 0.005
- 8
- 0.5
- 27
- 52
- 1
# Soil Data Summary Table

**BRRTS #:** 02-73-007107  
**SITE NAME:** Leysamarte Inn  
**SITE ADDRESS:** Leysamarte, WI

<table>
<thead>
<tr>
<th>BORING #</th>
<th>R-1</th>
<th>R-2</th>
<th>R-3</th>
<th>R-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPTH to Water Table (ft BGS)</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>DEPTH (ft BGS)</td>
<td>2.5 - 4.5</td>
<td>5 - 7</td>
<td>2.5 - 4.5</td>
<td>5 - 7</td>
</tr>
<tr>
<td>SOIL TYPE</td>
<td>clay</td>
<td>peat</td>
<td>clay</td>
<td>silty clay</td>
</tr>
</tbody>
</table>

## Soil RCLs (mg/kg)

<table>
<thead>
<tr>
<th>Soil RCLs (mg/kg)</th>
<th>Calculated 06/2014</th>
<th>Background</th>
<th>Lab</th>
<th>Detection Limit (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Industrial Direct Contact</td>
<td>Soil to GW</td>
<td>Surficial BTV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>0.75</td>
<td>&lt; 0.005</td>
<td>2.</td>
<td>0.5</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>5.9</td>
<td>&lt; 0.005</td>
<td>2.</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>Toluene</td>
<td>800</td>
<td>&lt; 0.005</td>
<td>10.</td>
<td>2.</td>
</tr>
<tr>
<td>Xylene</td>
<td>250</td>
<td>3.</td>
<td>10.</td>
<td>4.</td>
</tr>
<tr>
<td>PCE</td>
<td>2.</td>
<td>&lt; 0.005</td>
<td>2.</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>1.</td>
<td>&lt; 0.005</td>
<td>2.</td>
<td>3.</td>
</tr>
<tr>
<td>Benzo[a]pyrene</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Arsenic</td>
<td>5.</td>
<td>&lt; 0.5</td>
<td>10.</td>
<td>5.</td>
</tr>
<tr>
<td>Lead</td>
<td>240</td>
<td>25.</td>
<td>100.</td>
<td>50.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exceedance Highlights:</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Individual Exceedances (DC)</td>
</tr>
<tr>
<td>Cumulative Hazard Index (DC)</td>
</tr>
<tr>
<td>Cumulative Cancer Risk (DC)</td>
</tr>
</tbody>
</table>

Note: HI and CCR are from the DC_RCL Worksheet.
“Soil” Terms

- **RCL** — Cleanup level in soil (mostly calculated)
- **RSL** — Has algorithm for RCL calculation
- **BTV** — Background that may become RCL
- **UCL** — (Statistics)
Upper 95% Confidence Limit for the Mean

- Applies to a single population
  - adequate no. of sample
  - hotspots

- Can be compared to DC-RCL
Multiple Populations?

Yes.

Each “line” has its UCL, so several UCLs need to be calculated.
### Data for Contaminant X
(RCL for X is 10 mg/kg.)
Red font indicates RCL exceedance.

<table>
<thead>
<tr>
<th>Sample#</th>
<th>Soil-X (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.5</td>
</tr>
<tr>
<td>2</td>
<td>9.7</td>
</tr>
<tr>
<td>3</td>
<td>10.0</td>
</tr>
<tr>
<td>4</td>
<td>9.0</td>
</tr>
<tr>
<td>5</td>
<td>8.0</td>
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<tr>
<td>6</td>
<td>10.0</td>
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<td>7</td>
<td>9.1</td>
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<td>8</td>
<td>10.5</td>
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<tr>
<td>9</td>
<td>11.0</td>
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<tr>
<td>10</td>
<td>10.2</td>
</tr>
<tr>
<td>11</td>
<td>9.4</td>
</tr>
<tr>
<td>12</td>
<td>9.6</td>
</tr>
<tr>
<td>13</td>
<td>9.4</td>
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</tbody>
</table>

### General Statistics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Observations</td>
<td>13</td>
</tr>
<tr>
<td>Number of Distinct Observations</td>
<td>11</td>
</tr>
<tr>
<td>Number of Missing Observations</td>
<td>0</td>
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<tr>
<td>Minimum</td>
<td>8</td>
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<tr>
<td>Maximum</td>
<td>11</td>
</tr>
<tr>
<td>Mean</td>
<td>9.569</td>
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<tr>
<td>Median</td>
<td>9.6</td>
</tr>
<tr>
<td>SD</td>
<td>0.812</td>
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<tr>
<td>Coefficient of Variation</td>
<td>0.0848</td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>0.225</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.227</td>
</tr>
</tbody>
</table>

### Normal GOF Test

- Shapiro Wilk Test Statistic: 0.99
- Shapiro Wilk GOF Test: Data appear Normal at 5% Significance Level
- 5% Shapiro Wilk Critical Value: 0.866
- Lilliefors Test Statistic: 0.11
- Lilliefors GOF Test: Data appear Normal at 5% Significance Level
- 5% Lilliefors Critical Value: 0.246

Data appear Normal at 5% Significance Level

### Assuming Normal Distribution

<table>
<thead>
<tr>
<th></th>
<th>95% UCL</th>
<th>95% UCLs (Adjusted for Skewness)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95% Student's-t UCL</td>
<td>9.971</td>
<td>95% Adjusted-CLT UCL (Chen-1995) 9.924</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95% Modified-t UCL (Johnson-1978) 9.968</td>
</tr>
</tbody>
</table>

**Suggested UCL to Use**

- 95% Student's-t UCL: 9.971
Summary of Key Points

• **RCL** — Residual Contaminant Level
• **RSL** — Regional Screening Level
• **BTV** — Background Threshold Values
• **UCL** — Upper 95% Confidence Limit
Questions & Contacts

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