SOLID WASTE TECHNICAL GUIDANCE
PAL/ACL CALCULATIONS

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**Summary:** This guidance is written for use by facility owners and operators and DNR Staff to calculate Preventive Action Limits (PALs) and Alternative Concentration Limits (ACLs) for solid waste facilities under chs. NR 507 and NR 140, Wis. Adm. Code. It replaces the previous DNR Guidance SW9400015 dated May 6, 1994. The topics covered in this guidance include:

- Groundwater quality standards
- Assembling and evaluating baseline groundwater quality data
- Calculating PALs for indicator parameters
- Calculating ACLs for public health and welfare parameters
- Interpreting data from impacted wells

This guidance may be useful in the preparation and review of feasibility reports, plans of operations, groundwater monitoring plan modifications, or exemption requests to the groundwater standards under s. NR 140.28.

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## Groundwater Standards

Wisconsin's groundwater standards are set at two levels: an **enforcement standard (ES)** which is usually the same as the federal drinking water standard, and a lower **preventive action limit (PAL**) which triggers the need for remedial response or other action at a facility. In cases where the **background** concentration of a substance of public health or welfare concern exceeds either a PAL or an ES, the Department may establish an **alternative concentration limit (ACL)**. The ACL replaces a PAL, an ES, or both, when an exemption to the published standard is granted in accordance with s. NR 140.28. Standards for most public health and welfare substances are published in ch. NR 140, Wis. Adm. Code. PALs for indicator parameters and ACLs are determined from the baseline groundwater monitoring data as explained in this guidance.

- The ES and PAL values for substances of **public health** concern are listed in s. **NR 140.10, Table 1**.
- The ES and PAL values for substances of **public welfare** concern are listed in s. **NR 140.12, Table 2**.
- PALs for **indicator parameters** are calculated based on the greater of the following:
  The background water quality for that parameter plus 3 standard deviations, **or**
  The background water quality for that parameter plus the increase for that parameter listed in s. **NR 140.20, Table 3**. Indicator parameters do not have enforcement standards.
- ACLs for public health and welfare parameters (other than VOCs) are calculated based on historical data for each well as outlined in the following guidance.

The **confirmed exceedance** of a PAL, ES or ACL at any groundwater monitoring well requires responses from the owner of the facility in accordance with s. NR 508.04 Wis. Adm. Code. A confirmed exceedance at a designated **Subtitle-D well** triggers an **assessment monitoring** program for the Subtitle-D wells (s. NR 508.05, Wis. Adm. Code) in addition to the responses under s. NR 508.04, Wis. Adm. Code. For further information on assessment monitoring see Waste Management guidance # WA007.

**When are PAL calculations for indicator parameters submitted?**

For **existing** solid waste disposal facilities, the owner or operator submits indicator PAL calculations at the direction of the Department. Applicants for **proposed** solid waste disposal facilities (including proposed expansions) must submit indicator PAL calculations prior to (or as part of) the **plan of operation**.

**When should a facility owner or operator request an exemption and propose an ACL?**

A facility owner or operator may request an exemption from the groundwater standards if the **background concentration** (see NR 140.05(3), Wis. Adm. Code) of a public health or welfare parameter exceeds the NR 140 PAL or ES (see NR 140.12, Wis. Adm. Code).

Unless the Department grants an exemption, it may not approve a proposed facility, practice or operation at a location where a PAL or ES is exceeded. For an existing facility, a response under s. NR 140.24(2) or 140.26 (2), Wis. Adm. Code, is required unless an exemption is granted.

An exemption request to the groundwater standards may be submitted as a plan modification, or may be required as part of a feasibility report for a proposed facility. (see s. NR 512.13 (4) (b), Wis. Adm. Code) Under s. NR 507.29 (1), Wis. Adm. Code, an exemption request must contain:

a. A list of the specific wells and parameters for which an exemption is being requested.
b. Proposed ACLs and calculations in accordance with s. NR 507.27. (**see exception below**)
c. A discussion of how the criteria listed in s. NR 140.28(2)(3) or (4) are met.

Exception: For proposed facilities, including proposed expansions, the proposed ACLs and calculations may be submitted with the plan of operation. A minimum of 8 samples for each well and substance is recommended to calculate an ACL. However, only the initial 4 sample rounds are required to be submitted with a feasibility report. Thus, while the exemptions to the groundwater standards must be granted in the feasibility determination, the ACL cannot usually be calculated until the plan of operation is submitted.

**Steps for facility owners to use in calculating PALs for indicator parameters and ACLs for public health and welfare parameters**

1. Assemble the available groundwater monitoring data for the required baseline and detection monitoring parameters at each well. Use the entire set of analyses available for a given well and parameter. The larger the data set, the more accurate predictor the PAL will be. According to ss. NR 140.20, Wis. Adm. Code, you must have **at least** 8 background values to calculate PALs for indicator parameters. Similarly, the Department recommends that a minimum of 8 background values be used for calculating ACLs for public health and welfare parameters, other than VOCs.

2. Insure that the data lists include all of the parameters required for baseline and detection monitoring at your facility:
   a. For **municipal and industrial waste landfills, t**he required parameters are listed in ch. NR 507, Wis. Adm. Code as follows:
      i. Detection monitoring parameters except VOCs (see NR507.18(1) and NR 507 Appendix I, Tables 1 and 2)
      ii. Public health and welfare parameters not included as detection monitoring parameters (see NR 507.18(2) and NR 507 Appendix I, Table 3.)
      iii. VOCs (see NR 507.18(3) and NR 507 Appendix III)
   b. The required parameters for **small size construction and demolition waste landfills** are found in s. NR 503.09, Table 1.

c. The parameters for **intermediate size construction and demolition waste** landfills are found in s. NR 503.10, Table 3.

Attachment # 2 in this guidance contains a checklist of parameters and the minimum number of rounds required. Note that conditions may require monitoring for substances in addition to those listed in the code.

Present in tabular form all baseline groundwater quality monitoring results and any other relevant groundwater monitoring data in your submittal. Include the concentration, date of sampling and an indication of whether that value has been eliminated from the calculations. Generally the Department will not accept the use of computer programs to reject outliers. If you wish to use such a program, check with the Department staff first.

3. **Evaluate the data quality.** Evaluate the data and any supporting documentation to determine which data are usable for PAL/ACL calculations, and for ACL requests, whether the data supports the need for an ACL. Data used in the PAL/ACL calculations must have been collected using published sampling procedures and generated at a DNR certified lab using acceptable methods. The data should be representative of baseline conditions and be scientifically valid. Please refer to **Attachment 5** for more detail regarding the following considerations.

   a. Evaluate the field procedures and whether sample handling and preservation affect the data quality.
   b. Determine if the analyses were performed by a certified laboratory.
   c. Evaluate whether the facility selected appropriate methods of analysis: The goal of method selection is to use a procedure that reliably determines whether the concentrations in the groundwater exceed the PAL. Not all laboratories or methods can achieve the NR 140 PALs. The Department is aware of several substances that have been problematic. These substances are identified in Attachment 5.
   d. Evaluate causes of high sample variability.
   e. Determine whether there is valid justification for the elimination of any background data that were not used in the PAL or ACL calculations.

4. **Calculate PALs** for indicator parameters.
   a. Calculate the mean concentration plus 3 standard deviations for each indicator parameter and well. For duplicate samples, use duplicate number 01, unless there is a justifiable reason for rejecting it and using duplicate number 02. If the concentration of a substance is less than the limit of detection (LOD), a value of one-half the LOD should be used as the value for that sampling event, provided that the LOD is sufficiently low as discussed in the data quality section.
   b. Calculate the mean plus the NR 140.20 Table 3 increment.
   c. Choose the greater of either (a) or (b) for the selected parameter. Round the result up to the nearest two significant figures. For example, a value of 123.49 would be rounded up to 130.
   d. Present the calculated PAL for each well and parameter in a table or chart that includes the mean, standard deviation, PAL using 3 standard deviations, PAL using the NR 140 Table 3 increment, and the selected PAL. (see Attachment 6)

5. **Determine if any wells and parameters will need exemptions and ACLs.** For public health parameters and welfare parameters, exemptions are considered where the background groundwater quality data for a well and parameter is unaffected by a release from the facility, and 4 representative monitoring results meet one or more of the following criteria:
   a. Any of the values exceeds an ES, or
   b. Two or more of the values exceed a PAL, or

c. The average of the values is greater than the PAL.

Note that parameter concentrations must be above the LOQ to be considered an exceedance unless there is sufficient data to demonstrate the exceedance statistically with a significance level of 0.05 (NR 140.14(3)). If all detected results for a monitoring parameter are below the LOQ for the analyses, these concentrations do not exceed the PAL or ES for that parameter so an ACL is unnecessary.

6. **Calculate ACLs** for specific wells and parameters where appropriate. Normally, at the feasibility report stage there will not be a sufficient number of baseline samples available to calculate an ACL.
   a. For each well and parameter (other than VOCs), calculate the mean concentration of at least 8 sampling events plus 2 standard deviations. For duplicate samples, use duplicate number 01, unless there is a justifiable reason for rejecting it and using duplicate number 02. If the concentration of a substance (other than VOCs) is less than the limit of detection (LOD), a value of one-half the LOD should be used as the value for that sampling event provided, of course, that the LOD is sufficiently low as discussed in the data quality section. For example, if the result for a sampling event of lead was listed as "no detect" and the LOD was listed as 0.4 micrograms/liter, then the value used for that sampling event should be one half of the LOD or 0.2 micrograms per liter.
   b. Present the information for each well and parameter in a table or chart that includes the mean, standard deviation and proposed ACL.
   c. Include an exemption request which contains the ACL calculations and fully explains the origin of the exceedance(s) and why the criteria of s. NR 140.28 are met.

   The Department may, using professional judgement, establish an ACL for specific VOCs if a NR 140.28 exemption request is granted. If there is an ACL exceedance, the Department will use professional judgement to decide what action is appropriate for that exceedance. The Department will not accept ACL calculations for Volatile Organic Compounds (VOCs).

7. **Submit the PAL/ACL calculations and/or exemption request(s)** to the appropriate DNR Regional Office. As noted above, the document may be submitted as a groundwater monitoring plan modification request or may be required as part of a feasibility report or plan of operation for a proposed new or expanded facility. PAL/ACL calculations and NR 140.28 exemption requests must be submitted under the seal of a registered professional geologist. Upon receipt of the submittal, the Department will send an invoice for the appropriate review fee. (see NR 520 Table 3) The DNR hydrogeologist assigned to the facility will review the submittal and decide if the PAL/ACLs are approvable. If so, the PALs/ACLs will be established as groundwater standards in the facility's plan of operation.

## III. IMPACTED WELLS

### IDENTIFICATION OF IMPACTED WELLS

A well is considered "impacted" if it has high concentrations of one or more substances when compared to other wells screened in the same geologic formation or exceedances of the groundwater standards in ch. NR 140, Wis. Adm. Code. The high concentration or exceedance may be due to several factors, including: a release from the facility, a release from an adjacent facility, prior land uses, or elevated natural background concentration of a substance.

Owners of some facilities, particularly those located in a fine-grained soil environment, may decide to calculate ACLs rather than use the established PALs for public health and welfare parameters because of high background levels reflecting natural impacts. Those facilities must provide adequate justification for

an NR 140.28 exemption when requesting the ACLs so that the Department can determine whether the high levels are natural background or the result of a release.

One or more of any of the following methods or tools may be used to identify impacted wells. The Department is willing to review other valid means of identification which you provide.

1. **Prior Investigation**

A well may have been identified as impacted during an investigation. Again, be sure to check if the well has been impacted for all parameters from the time of installation or if at least 8 rounds of "clean" data are available to calculate a PAL or ACL.

2. **Box Plots**

You may construct non-parametric box plots using all data for each parameter at each well; see attachments 7 and 9 for further information about box plots. For easy comparison with a "clean" well, include a background well on each set of box plots. Past experience has shown us that the "clean" range is generally within ±5NP (nonparametric) units of the median of data from all wells on site, where the site-wide median is shown as "0" on the horizontal axis of the box plots.

If box plots indicate that the well appears impacted, you can inspect the time vs. concentration plots, determine if there is a period of time for which you have at least 8 rounds of "clean" data available and decide whether those values represent the background.

Attachment 9 shows both the time vs. concentration plot and box plots for field conductivity data at 4 wells. Used together, box plots and time vs. concentration plots aid in the interpretation of water quality data. Attachment 9 illustrates how an impacted well (MW-2) appears on both a box plot and time vs. concentration plot. Note that the box plot for well MW-2 is greater than 5 NP units from the median.

3. **Time vs. Concentration Graphs**

Construct time vs. concentration graphs as shown in Attachment 8 using all data for each parameter at each well. Use no more than 3 downgradient and 1 upgradient well on each plot to avoid clutter. The upgradient well will most likely be a flat line representing a low concentration through time. The side- or downgradient wells might be any combination of flat and/or positive or negative slopes. You may note the dates of significant events such as cover placement or the opening of a new phase on the plot. Use the plots to find the period of time during which the samples most representative of background were collected. Calculate the PAL and/or ACL using those representative values, of which there must be at least 8.

Use professional judgement to decide whether a well is so impacted that PALs cannot be calculated. Attachment 9 illustrates data for well MW-2 which appears to be impacted by a release(s) from the facility. If you have such wells, submit a brief justification for the way you established the PAL.

4. **Linear Regression**

Linear regression, a parametric statistic, can help you decide whether there is an increasing concentration with time; however, it assumes a **normal distribution** for the data set. That assumption is **usually not valid** for groundwater samples. The Department will accept use of linear regression as evidence of impacted groundwater only if there is a normal distribution as determined by using a skewness test. (See "Methods for Determining Compliance with Groundwater Quality Regulations at Waste Disposal

Facilities" dated January, 1989, by S. Fisher and K. Potter for skewness methodology.) This document is available from the Bureau of Waste Management upon request.

5. **Maps**

Plan view maps of the facility with the concentration of the parameter of interest noted next to the well will provide locational information which may help you decide how to handle an apparently impacted well. Be sure to include only wells which terminate in the same geologic formation or at the same elevation. Note, too, the well locations in respect to any possible contamination sources other than the waste mass itself. Contouring and color coding the concentration ranges can be a good visual tool. Preparation of such maps at several elevations, along with flow nets, cross sections, and fence diagrams will provide 3-dimensional insight to any impacts.

## HOW TO CALCULATE PAL/ACLs FOR IMPACTED WELLS

NOTE: *A well may be impacted for one parameter and not for others. Be sure to check all parameters.*

1. Calculate the PAL using both the first 8 (unimpacted) points representative of background and the entire data set. Compare the results and use the smaller of the two numbers as the PAL.

2. If all data for a parameter, not just recent data, are impacted (and since by definition a PAL cannot be calculated at such a well):

   a. Use the PAL calculated at an upgradient well which is screened in the same formation, or

   b. If an upgradient well is not screened in the same formation:

      i. find another uncontaminated well which is appropriately screened, as it will probably have similar water quality, and use the PAL for that well, or

      ii. use the PAL for a well with similar water quality, as indicated by box plots with similar medians and confidence intervals for **other** parameters.

         NOTES: *You may use a well that is part of an adjacent facility's monitoring system only if it meets the above criteria better than any of the subject facility's wells.*

         *DO NOT merge data from monitoring wells and private wells because these well types are constructed and sampled so differently.*

   c. Calculate an indicator PAL using the impacted data and provide adequate justification for its use (i.e. the upgradient well is downgradient of an adjacent unlined facility).

## IV. DEFINITIONS

An **Alternative Concentration Limit** (ACL) is defined in s. NR 140.05 (1m), Wis. Adm. Code, as the concentration of a substance in groundwater established by the department for a site to replace a preventive action limit or enforcement standard or both, from Table 1 or 2, when an exemption is granted in accordance with s. NR 140.28.

**Background groundwater quality or background concentration** is defined in s. NR 140.05(3), Wis. Adm. Code, as groundwater quality at or near a facility, practice or activity which has not been affected by that facility, practice or activity

**Baseline** is defined in s. NR 500.03(20) as the groundwater quality at a point that is measured after the parameters have stabilized following installation of a monitoring well.

An **Enforcement Standard** (ES) is defined as a numerical value expressing the concentration of a substance in groundwater which is adopted under s. 160.07, Stats. (establishment of enforcement standards; substances of public health concern), and s. NR 140.10, Wis. Adm. Code, (public health related groundwater standards) or s. 160.09, Stats. (establishment of enforcement standards; substances of public welfare concern), and s. NR 140.12, Wis. Adm. Code, (public welfare related groundwater standards).

An **error log** identifies data points which are eliminated because of a sampling error such as a defective conductivity meter. It may be combined with the nullify log if points are identified by an "e" or "n".

The **limit of detection** is the lowest concentration for an analytical test method and sample matrix at which the presence of a substance can be identified in an analytical sample, with a stated degree of confidence, regardless of whether the concentration of the substance in the sample can be quantified.

The **limit of quantitation** is defined in NR 140.05(13) as the level above which quantitative results may be obtained with a specified degree of confidence.

The arithmetic **mean** for a parameter at one well is the sum of the concentrations divided by the number of values used.

A **nonparametric statistic** is one that does not depend on the data being drawn from any particular distribution, such as a normal distribution.

A **nullify log** identifies data points which are eliminated for a reason other than sampling error, such as high concentration due to well construction. It may be combined with the error log if points are identified by an "e" or "n".

A **Preventive Action Limit** (PAL) is defined in s. NR 140.05(17), Wis. Adm. Code, as a numerical value expressing the concentration of a substance in groundwater which is adopted under s. 160.15, Stats. (establishment of PALs), and either listed in s. NR 140.10 (public health related groundwater standards), or s. NR 140.12 (public welfare related groundwater standards), or calculated under s. NR 140.20 (indicator parameter groundwater standards).

The **standard deviation** for a group of samples is defined in ch. NR 140.20(2), Wis. Adm. Code, as the square root of the value of the sum of the square of the difference between each sample in the sample group and the mean for that sample group divided by the number of samples in the sample group where the sample group has 30 or more samples and by one less than the number of samples in the sample group where the sample group has less than 30 samples.

A **uniform scale** is one which has consistent, non-logarithmic increments.

**Legal Note:** This document is intended solely as guidance, and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. This guidance does not establish or affect legal rights or obligations, and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

**Attachments**:

1. PAL/ACL Calculations
2. Checklist Groundwater Parameters
3. Example Data Presentation Table
4. Example Error Log
5. Evaluating Data Quality
6. Example Calculation Summary
7. Description of GEMS Box Plots
8. Time vs. Concentration Plot
9. Example Impacted Well Plots

Attachment 1

# PAL/ACL CALCULATIONS CHECKLIST
August 2001

Bureau of Waste Management
Wisconsin Department of Natural Resources

This checklist is designed to be used in conjunction with the PAL/ACL Calculations Guidance for Solid Waste Facilities. (Guidance # WA___)

1. Assemble the data.
   ____ Acceptable lab procedures
   ____ Acceptable limits of detection
   ____ Has all data been submitted to DNR in the proper electronic data format (diskette)

2. Present baseline groundwater quality results.
   ____ All required parameters (see Attachment #2)
   ____ At least 8 baseline values for calculating PALs or ACLs (exclude duplicate samples)
   ____ Both well name and DNR Well ID# are used to identify the well
   ____ All sample dates and concentrations are reported
   ____ Data not used for calculations are clearly marked

3. Justify the elimination of data
   ____ Valid justification is presented for eliminated data values

4. Calculate Indicator PALs
   ____ Tabular presentation including number of values, means and standard deviations
   ____ Present mean + 3 standard deviations and NR 140 Table 3 incremental increase
   ____ Select and indicate PAL values
   ____ Round “up” and record 2 significant figures

5. Calculate any ACLs
   ____ Tabular presentation including number of values, means and standard deviations
   ____ ACL calculation based on mean + 2 standard deviations
   ____ Exemption request and explain why NR 140.28 criteria are met.

6. Determine which, if any, wells are impacted
   ____ Data presentation
   ____ Justification for elimination of data
   ____ PAL calculation using entire data set and unimpacted data
   ____ Use of alternate wells to provide a PAL is thoroughly explained
   ____ ACL calculations, if needed

Submit the report to the Department (May be part of a Feasibility Report, Plan of Operation or Plan Modification)
   ____ Signature of a hydrogeologist
   ____ Submittal includes proposed PALs and any ACLs
   ____ Submittal includes exemption requests and explanation of how NR 140.28 criteria are met

Attachment 2

BASELINE GROUNDWATER PARAMETERS

See NR 507.18, Wis. Adm. Code for specific requirements

| Part I Baseline for Detection Monitoring Parameters - Except VOCs (Minimum of 8 samples - 4 with a feasibility report plus 4 with a plan of operation) | | | |
|---|---|---|---|
| Waste Type | Parameter # and Name | Parameter Type | NR 140 Standard |
| Municipal Solid Waste (These are required for all sites) | ☒ 39036 Alkalinity, total filtered | Indicator | Calculate PAL |
| | ☒ 00940 Chloride | Public Welfare | Table 2 |
| | ☒ 00341 COD, filtered | Indicator | Calculate PAL |
| | ☒ 00094 Field conductivity @ 25°C | Indicator | Calculate PAL |
| | ☒ 00400 Field pH | Indicator | Calculate PAL |
| | ☒ 00010 Field temperature | Indicator | Not Calculated |
| | ☒ 72020 Groundwater elevation* | N/A | N/A |
| | ☒ 22413 Hardness, total filtered | Indicator | Not Calculated |
| Additional parameters for waste types listed in NR 507, Appendix I, Table 2. (Check if applicable) | ☐ 00608 Ammonia nitrogen, dissolved | Indicator | Calculate PAL |
| | ☐ 01020 Boron, dissolved | Public Health | Table 1 |
| | ☐ 01025 Cadmium, dissolved | Public Health | Table 1 |
| | ☐ 00950 Fluoride, dissolved | Public Health | Table 1 |
| | ☐ 01049 Lead, dissolved | Public Health | Table 1 |
| | ☐ 00631 Nitrate + Nitrite (as N), dissolved | Public Health | Table 1 |
| | ☐ 01145 Selenium, dissolved | Public Health | Table 1 |
| | ☐ 00930 Sodium, dissolved | Indicator | Calculate PAL |
| | ☐ 00946 Sulfate, dissolved | Public Welfare | Table 2 |
| Part II Baseline for Public Health and Welfare Parameters Not Included as Detection Monitoring Parameters (4 Samples with the feasibility report plus an additional 4 samples with the plan of operation for any well meeting NR 507.18 (2) (b) 1, 2, or 3.) | | | |
| Monitoring Wells | Parameter # and Name | Parameter Type | NR 140 Standard |
| All Monitoring Wells | ☒ 01056 Manganese, dissolved | Public Welfare | Table 2 |
| | ☒ 00946 Sulfate, dissolved | Public Welfare | Table 2 |
| | ☒ 01090 Zinc, dissolved | Public Welfare | Table 2 |
| | ☒ 01000 Arsenic, dissolved | Public Health | Table 1 |
| | ☒ 01005 Barium, dissolved | Public Health | Table 1 |
| | ☒ 01025 Cadmium, dissolved | Public Health | Table 1 |
| | ☒ 01030 Chromium, dissolved | Public Health | Table 1 |
| | ☒ 01040 Copper, dissolved | Public Health | Table 1 |
| | ☒ 00950 Fluoride, dissolved | Public Health | Table 1 |
| | ☒ 01049 Lead, dissolved | Public Health | Table 1 |
| | ☒ 71890 Mercury, dissolved | Public Health | Table 1 |
| | ☒ 00631 Nitrate + Nitrite (as N), dissolved | Public Health | Table 1 |
| | ☒ 01145 Selenium, dissolved | Public Health | Table 1 |
| | ☒ 01075 Silver, dissolved | Public Health | Table 1 |
| Additional parameters for Subtitle D wells only. (All 6 are required for Subtitle D wells.) | ☐ 01095 Antimony, dissolved | Public Health | Table 1 |
| | ☐ 01010 Beryllium, dissolved | Public Health | Table 1 |
| | ☐ 01035 Cobalt, dissolved | Public Health | Table 1 |
| | ☐ 01065 Nickel, dissolved | Public Health | Table 1 |
| | ☐ 01057 Thallium, dissolved | Public Health | Table 1 |
| | ☐ 01085 Vanadium, dissolved | Public Health | Table 1 |
| Part III Baseline for VOCs (2 Total. Plus an additional 2 VOC rounds at any well with a VOC above the LOD in either of the first 2 rounds. (Submitted with the feasibility report) | | | |
| All wells | ☒ VOC Scan (See list in NR 507, Appendix III) | Public Health | Table 1 |

* Under NR 512.09(4)(e), Wis. Adm. Code, stabilized groundwater elevation measurements shall be obtained from each well on a monthly basis for a minimum of 6 months prior to submittal of the feasibility report.

Attachment 3

Example of data presentation showing dates and concentrations for indicator parameters at one well. Note the “N” or Nullify flags which identify values that are not used in the PAL or ACL calculations. These values should be recorded on a log sheet along with the reason for rejection of the values. See Figure 4 for an example of a “nullify log.”

Facility Name _____ License Number _____ Monitoring Well W-2 (ID# 002)

| Date of Sample | Field Conductivity at 25C MICROMHO | COD, Filtered Mg/l | Total Hardness, Filtered Mg/l | Total Alkalinity, Filtered Mg/l |
|---|---|---|---|---|
| 10/14/1981 | 700 N | 94 N | 254 N | 253 N |
| 12/11/1981 | 625 N | 110 N | 240 N | 278 N |
| 03/18/1982 | 775 N | 101 N | 272 N | 242 N |
| 06/08/1982 | 600 | 59 | 194 | 198 |
| 09/13/1982 | 475 | 67 | 78 | 24 |
| 12/22/1982 | 450 | 32 | 80 | 36 |
| 03/10/1983 | 445 | 28 | 208 | 210 |
| 06/09/1983 | 370 | 50 | 148 | 152 |
| 09/22/1983 | 410 | 56 | 170 | 170 |
| 12/13/1983 | 390 | 54 | 160 | 164 |
| 03/23/1984 | 250 | 55 | 156 | 156 |
| 06/18/1984 | 260 | 38 | 144 | 142 |
| 10/16/1984 | 180 | 83.8 | 104 | 102 |
| 12/28/1984 | 155 | 33 | 104 | 96 |
| 03/20/1985 | 260 | 31.7 | 132 | 110 |
| 06/28/1985 | 310 | 39 | 140 | 140 |
| 09/26/1985 | 240 | 46 | 94 | 88 |
| 12/13/1985 | 255 | 16 | 110 | 110 |
| 03/24/1986 | 195 | 23 | 88 | 82 |
| 06/30/1986 | 360 | 49 | 170 | 160 |
| 09/24/1986 | 240 | 42 | 96 | 98 |
| 12/18/1986 | 310 | 25 | 130 | 140 |
| 03/18/1987 | 275 | 25 | 130 | 120 |
| 06/24/1987 | 350 | 27 | 180 | 170 |

Attachment 4

Example of an error and nullify log. Note that the “comment” column specifies the reason for excluding the point from the PAL or ACL calculation.

| Facility Name: _____ License Number: _____ | | | | |
|---|---|---|---|---|
| Reviewer: _____ Date: _____ | | | | |
| Well Number | Parameter | Sample Date | Sample Result | Comments |
| 002 | COD | 10/14/1981 | 94.0 | Initial high value due to well construction |
| 002 | COD | 12/11/1981 | 110.0 | Initial high value due to well construction |
| 002 | COD | 03/18/1982 | 101.0 | Initial high value due to well construction |
| 002 | Alkalinity | 10/14/1981 | 253 | Initial high value due to well construction |
| 002 | Alkalinity | 12/11/1981 | 278 | Initial high value due to well construction |
| 002 | Alkalinity | 03/18/1982 | 242 | Initial high value due to well construction |
| 002 | Hardness | 10/14/1981 | 253 | Initial high value due to well construction |
| 002 | Hardness | 12/11/1981 | 278 | Initial high value due to well construction |
| 002 | Hardness | 03/18/1982 | 242 | Initial high value due to well construction |
| 003 | Field Cond. | 06/08/1982 | 1425 | Well near salt storage area, flushed out |
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Attachment 5

## Evaluating the Data Quality

Evaluate the data and any supporting documentation to determine which data are usable for PAL/ACL calculations and, for ACL requests, whether the data supports the need for an ACL. Data used in the PAL/ACL calculations must have been collected using published sampling procedures and generated at a DNR certified lab using acceptable methods. The data should be representative of baseline conditions and be scientifically valid.

a. Evaluate the field procedures and whether sample handling and preservation affect the data quality: For parameters that require field filtration, consider whether there were any delays between sample collection and filtration. For VOCs, consider the length of time and how samples were handled between sample collection and delivery to the laboratory. If VOC samples foamed or effervesced during acid preservation, an alternate preservative should have been used or, if the no chemical preservative was added, the sample holding time is reduced to 7 days. If contaminants are detected in field blanks, determine their source and the effect on the sample results. Boron results may be biased high from sample contact with glass or the preservative. (e.g. acid shipped to the field in glass ampules).
b. Analysis by a certified laboratory: Verify that the analyses were generated in a Wisconsin-certified laboratory and that the laboratory held the appropriate certifications for the parameters it analyzed. The laboratory should be able to provide a copy of its certificate, which lists test categories and parameters. This Department posts lists of certified laboratories on its web site: www.dnr.state.wi.us/org/es/science/lc .
c. Selected appropriate methods of analysis: The goal of method selection is to use a procedure that reliably determines whether the concentrations in the groundwater exceed the PAL. There are three considerations in method selection:
    i. The method is approved in rule or by the Department. Appendix II in NR 507 lists analytical methods; however, these references are dated. The Department may approve additional alternative methods for monitoring parameters per NR 507.17 (4) and NR 149.12. EPA-approved methods for water analyses are acceptable for baseline monitoring per NR 149.12(1) provided they are suitable for quantitative analysis (not screening methods or qualitative determinations). In addition, the Department has approved fluorescence methods for mercury as an emerging technology pursuant to NR 149.12(2) in several laboratories. A list of laboratories with approved alternate mercury procedures can be found at www.dnr.state.wi.us/org/es/science/lc/info/Hg_low.htm. If you have a question whether a method is approved or accepted, contact the Department.
    ii. The method is appropriate for the analyte concentration in the sample. The method selected for the analysis should be capable of quantifying sample concentrations (i.e. concentrations are above the LOQ) below the PAL; however, insisting on low detection limits for samples with high analyte concentrations or matrix interferences may compromise data quality.
    iii. The method has sufficient sensitivity. When sample concentrations are low, the method must be capable of quantifying sample concentrations below the PAL. If approved methods are incapable of quantifying sample concentrations below the PAL, the method selected must produce the lowest available LOD and LOQ (NR 140.16 (2)). If substances are reported with concentrations between the LOD and LOQ and this is the result of sample dilution, the facility owner or consultant should request that the laboratory report results for the affected substances from a lesser dilution. If this is not possible, the facility owner or consultant should document why quantifiable results could not be obtained.

It may not be possible to achieve the NR 140 PAL for the following VOCs:

| Substance | CAS Number | PAL (µg/L) | Target LOD (µg/L) |
|---|---|---|---|
| Bromodichloromethane | 75-27-4 | 0.06 | 0.2 |
| 1,3-Dichloropropene | | | |
| cis | 10061-01-5 | 0.02 | 0.2 |
| trans | 10061-02-6 | 0.02 | 0.2 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.02 | 0.2 |
| Vinyl chloride | 75-01-4 | 0.02 | 0.2 |

Although not all laboratories can achieve the target LODs listed above, several certified laboratories are capable of determining these substances at concentrations below this target. Facilities should consider these target LODs when selecting and contracting with a laboratory and evaluating the data.

For several metals, the methods listed in Appendix II may be sensitive enough to quantify sample results below their PALs; however, this is highly dependent on the laboratory's instrument and how they perform the method. Frequently, the PALs fall between the LODs and LOQs for arsenic, cadmium, lead and selenium. It may take special handling (e.g. concentrating samples) to achieve lower LOQs. EPA has approved ICP-MS methodology, which is capable of detecting and quantifying metals below their PALs routinely. The Department will accept results generated using EPA-approved ICP-MS methods EPA 200.8 or SW-846 method 6020, or equivalent ICP-MS methodology. The table below lists the metals that are potentially problematic with estimated LODs for each technique.

| | | *Range of Quantitation Limits** | | | |
|---|---|---|---|---|---|
| Substance | PAL (µg/L) | ICP | GFAA | Hydride | ICP-MS |
| Antimony | 1.2 | 3 - 20 | 3 - 12 | 3 | 0.06 - 2.5** |
| Arsenic | 5 | 5 - 20 | 2 - 10 | 6 | 0.1 - 3** |
| Cadmium | 0.5 | 0.15 - 1.2 | 0.15 - 1.2 | -- | 0.03 - 0.7 |
| Lead | 1.5 | 2 - 10 | 0.4 - 10 | -- | 0.05 - 2.1 |
| Thallium | 0.4 | 7 - 20 | 1.5 - 10 | -- | 0.03 - 0.15 |
| Selenium | 10 | 5 - 30 | 2 - 5 | 3 | 0.35 - 8 |

| | | CVAS | P&T Fluorescence | Fluorescence |
|---|---|---|---|---|
| Mercury | 0.2 | 0.02 -0.2 | 0.0002 - 0.001 | 0.001 - 0.015 |

*Estimated quantitation limits are based on actual data reported except for hydride which is based on method references. Individual lab performance may vary.
**The upper range for ICP-MS is higher than normally expected but was reported with samples.

d. Evaluate causes of high sample variability: High sample variability between sampling events may indicate problems with data quality or quantity. The facility owner or consultant should evaluate whether sampling, sample handling, or analytical procedures are contributing to the variability. If the groundwater has a high intrinsic variability, it may be necessary to collect more than the required number of samples to obtain a reliable PAL/ACL.
e. Determine whether there is valid justification for the elimination of any background data which were not used in the PAL or ACL calculations. This could include initial high values due to well construction, sampling error, laboratory error, reporting error, matrix interference or high field or method blank readings. Results may be biased low if matrix interferences are present or dissolved parameters are not filtered appropriately. The facility owner or consultant should document why any data are eliminated.

Attachment 6

Example of a chart showing the number of sample results used, mean, standard deviation, mean + 3 standard deviations, the mean + "Minimum increase" and the selected PAL for a single parameter at all wells.

Parameter: Total Alkalinity, filtered
NR 140 Minimum Increase: 100 mg/l

| Well (DNR #) | No of Samples | Mean | Std. Dev. | 3 X Std. Dev. | Mean + 3 Std. Dev. | Mean + Minimum Increase | PAL |
|---|---|---|---|---|---|---|---|
| MW 1 (001) | 8 | 257 | 51 | 152 | 409 | 357 | 410 |
| MW 1P (002) | 8 | 117 | 18 | 54 | 171 | 217 | 220 |
| MW 2 (003) | 8 | 139 | 19 | 58 | 197 | 239 | 240 |
| MW 2P (004) | 8 | 116 | 23 | 70 | 186 | 216 | 220 |
| MW 3 (005) | 8 | 187 | 33 | 99 | 286 | 287 | 290 |
| MW 3P (006) | 8 | 121 | 25 | 74 | 194 | 221 | 230 |
| MW 6 (009) | 8 | 124 | 16 | 48 | 172 | 224 | 230 |
| MW 6P (010) | 8 | 189 | 30 | 91 | 279 | 289 | 290 |
| MW 7 (011) | 8 | 190 | 15 | 45 | 235 | 290 | 290 |
| MW 7P (012) | 8 | 147 | 16 | 47 | 194 | 247 | 250 |
| MW 16 (041) | 8 | 212 | 22 | 65 | 277 | 312 | 320 |
| MW 17 (042) | 8 | 143 | 18 | 55 | 198 | 243 | 250 |
| MW 17P (043) | 8 | 96 | 51 | 153 | 249 | 196 | 250 |
| MW 18 (044) | 8 | 235 | 21 | 62 | 297 | 335 | 340 |
| MW18P (045) | 8 | 152 | 20 | 59 | 211 | 252 | 260 |
| MW 19 (046) | 8 | 196 | 15 | 46 | 242 | 296 | 300 |
| MW 19P (047) | 8 | 134 | 27 | 80 | 214 | 234 | 240 |
| MW 20 (048) | 8 | 187 | 8 | 24 | 211 | 287 | 290 |
| MW 21 (049) | 8 | 214 | 10 | 31 | 245 | 314 | 320 |
| MW 22 (050) | 8 | 237 | 27 | 82 | 319 | 337 | 340 |
| MW 25 (055) | 8 | 198 | 13 | 40 | 238 | 298 | 300 |
| MW 26 (056) | 8 | 205 | 19 | 56 | 261 | 305 | 310 |
| MW 27 (057) | 8 | 94 | 12 | 37 | 131 | 194 | 200 |
| MW 28 (058) | 8 | 117 | 17 | 52 | 169 | 217 | 220 |
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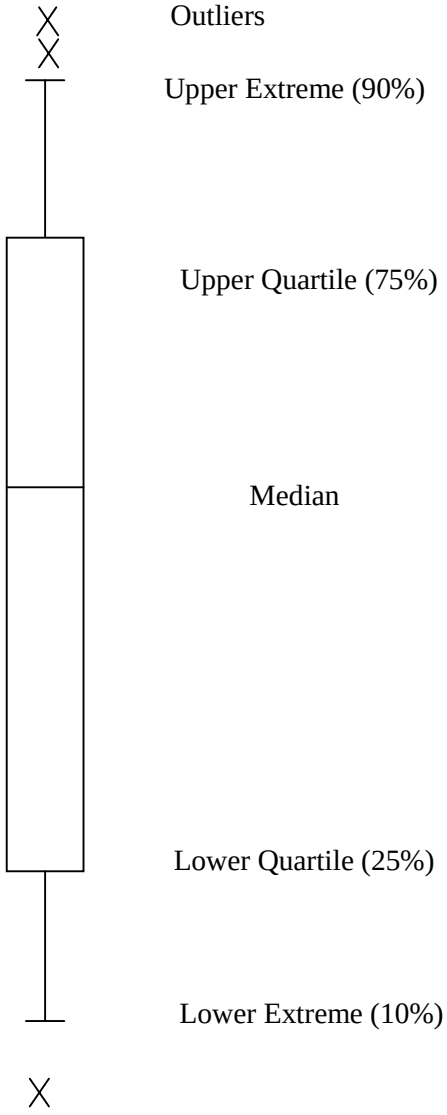
Attachment 7

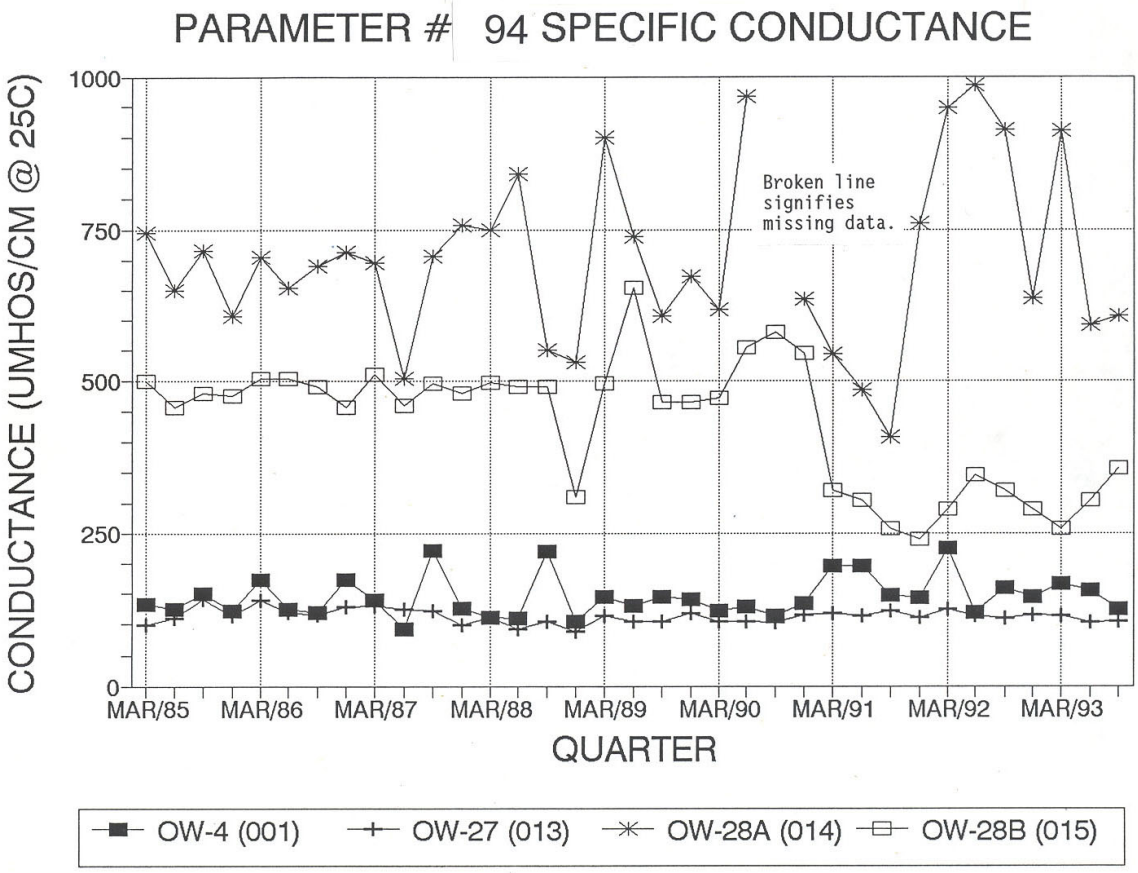
# Description of GEMS Box Plots

Box plots can be an effective way to transmit a large amount of information in a small amount of space. At least five sample data are required to produce a box plot. A box plot consists of a **median value** for the data, the **box** containing 50% of the data values with the top line at 75% of the data and the bottom line at 25%. The **whiskers** are drawn to include from 10% to 90% of the data points and the outlier stars represent data outside of this distance.

The Department uses a non-parametric scale that allows different parameters to be compared with each other, even though their units might not be the same. (See Attachment 9) This system puts zero NP (non-parametric) value as the site median for the parameter and adjusts the values of the parameter to a non-parametric value. The site median is a rough indicator of the site background for the parameter, although be aware that the whole site could be above the NR 140 PAL. The "clean" range is considered to be 0 plus or minus 5 NP units, although if individual box plots deviate from the majority they should be investigated. Deviations greater than 5 NP units indicate likely contamination. If the box extends beyond 5 NP units the well should be investigated further. Large interquartile (box) sizes mean that there is a lot of variation in the data for the well and is often characteristic of a well with contamination. Box plots of wells with similar water quality have overlapping confidence intervals. That is the medians and 95% confidence intervals of these wells are usually similar to one another.

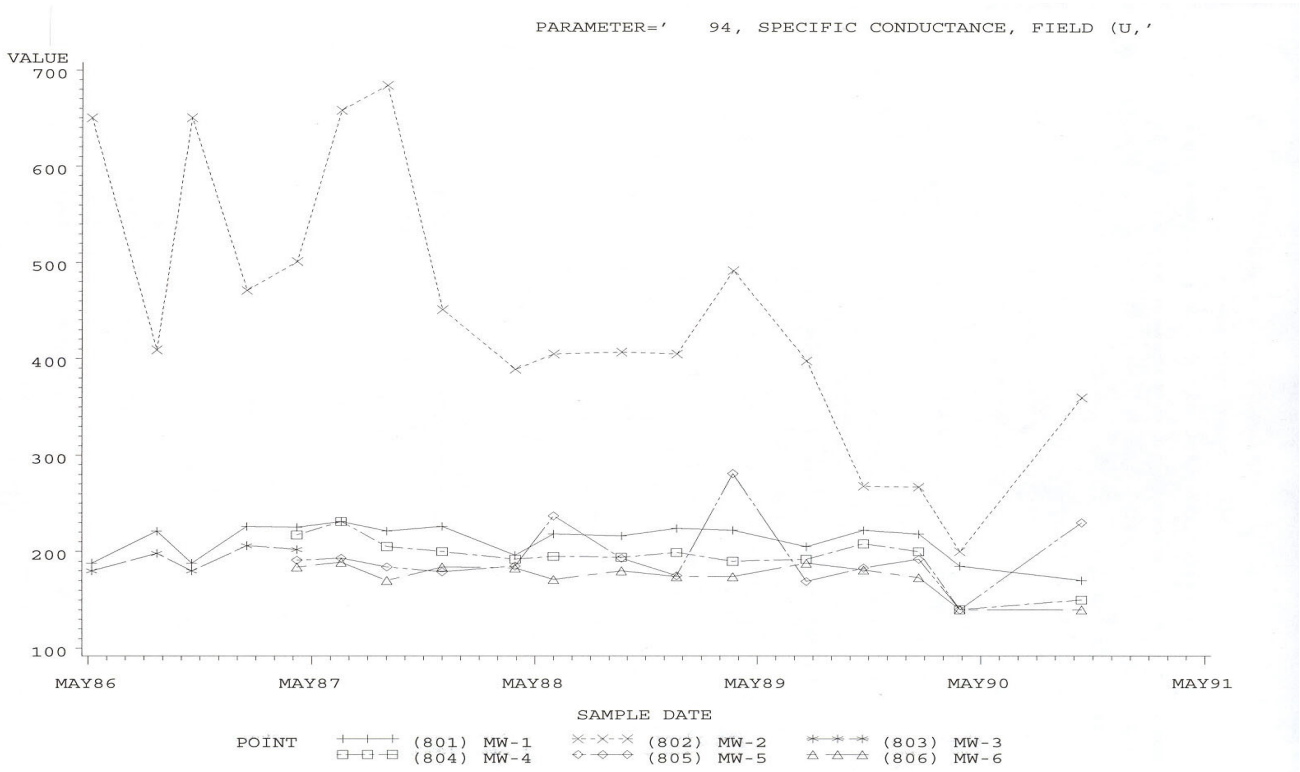


Attachment 8
Time vs. Concentration Plot



Attachment 9
Example of an Impacted Well

Time vs. concentration plot showing an impacted well (MW-2).




Box plot showing the same impacted well as above (MW-2).