GROUNDWATER MONITORING PLAN

ONALASKA MUNICIPAL LANDFILL SITE
Onalaska, Wisconsin

WA 38-5NL5 / Contract No. 68-W8-0040

May 1992

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GLT272/018.51

Onalaska Groundwater Monitoring Plan

Introduction

This plan describes the long-term groundwater monitoring program for the Onalaska Municipal Landfill site located in Onalaska Township, Wisconsin (Figures 1 and 2). The monitoring program is a necessary part of the remedial action plan outlined in the U.S. Environmental Protection Agency's (EPA) Record of Decision (ROD). The groundwater monitoring program was designed to monitor the effectiveness of the groundwater collection and monitoring systems in meeting the requirements of the ROD and potential adverse impacts on nearby wetlands. Although not specifically addressed as a ROD requirement, monitoring of adjacent surface water and sediments is included as part of the groundwater monitoring plan. Monitoring of treated groundwater discharge will be addressed in a separate plan [1].

Contaminants Found in Groundwater during the Remedial Investigation

Groundwater samples were collected from monitoring wells during the Remedial Investigation (RI) in the spring and summer of 1989. Contaminant concentrations in the groundwater at individual monitoring well locations within the landfill or at the landfill boundary exceeded one or more standards or criteria. The Safe Drinking Water Act maximum contaminant levels (MCLs) for arsenic; barium; benzene; 1,1-dichloroethene; toluene; 1,1,1-trichloroethane (1,1,1-TCA); trichloroethene (TCE); and xylene were exceeded at one or more monitoring well locations. The Wisconsin Groundwater protective action limits (PALs) for benzene; arsenic; barium; chromium; 1,1-dichloroethene; 1,1,1-TCA; TCE; toluene; and xylene were exceeded at one or more monitoring well locations.

A series of shallow groundwater samples were collected during the RI and were analyzed using a close support laboratory. The primary objectives of the shallow groundwater analysis were to determine the extent of the floating non-aqueous phase and to help select groundwater monitoring well locations. The close support laboratory analyzed a total of 81 samples for the following organic compounds:

- Toluene
- Total xylenes
- 1,1,1-TCA
- TCE
- Perchloroethylene (PCE)

These compounds were selected on the bases of historical groundwater analyses, site history, and their chemical properties (e.g., mobility). Measured concentrations of toluene were as high as 43,000 μg/L. Of the three chlorinated compounds analyzed for, 1,1,1-TCA was the most prevalent, and was found at concentrations as high as 730 μg/L.

Two rounds of groundwater sampling for contract laboratory analysis were conducted. These samples were analyzed for the complete target compound list (TCL) and 13 special analytical services (SAS) parameters.

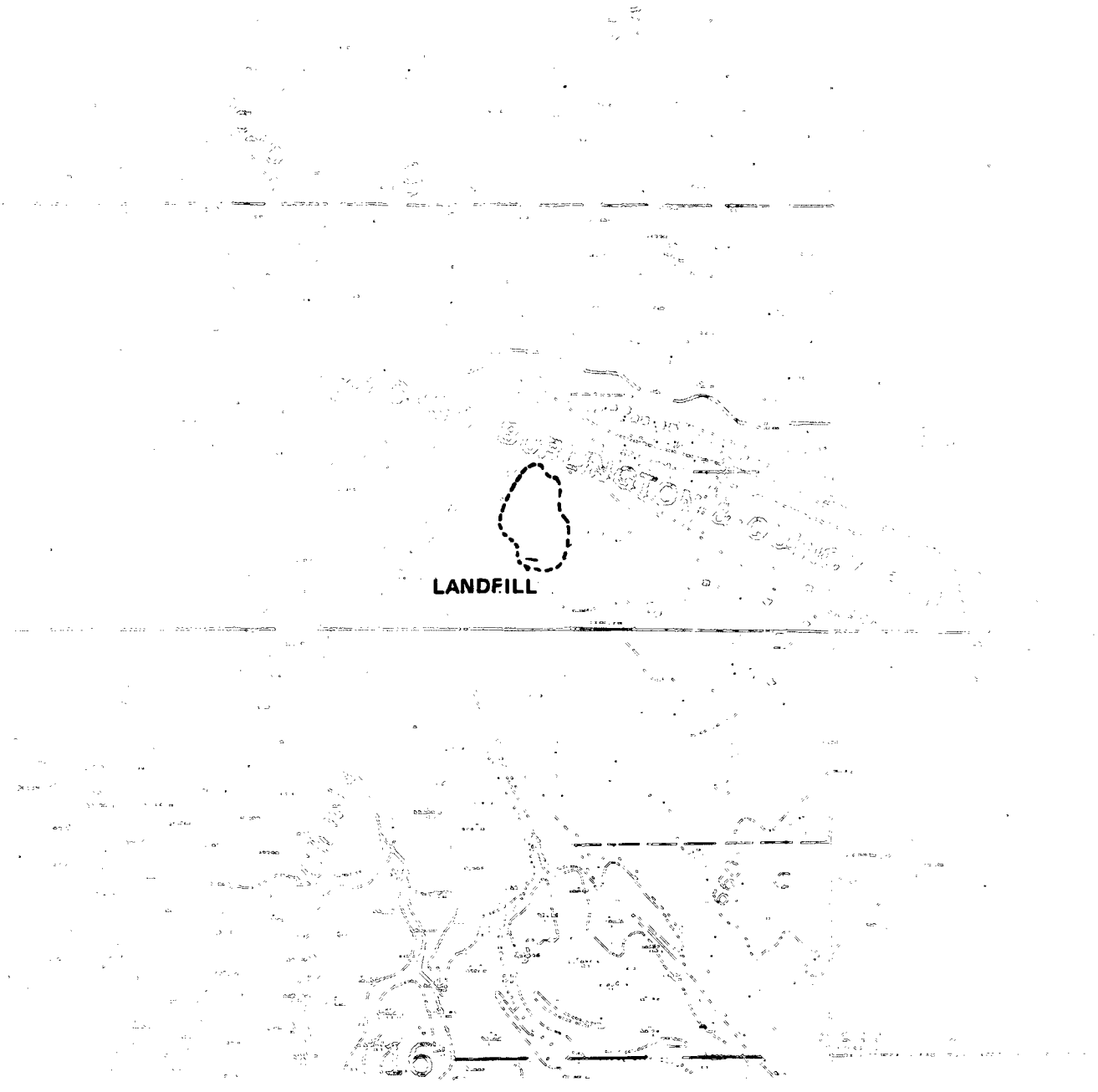
Volatile organic compounds (VOCs) were generally observed to be present at concentrations much greater than semivolatile organic compounds (SVOCs), sometimes more than an order of magnitude greater. The majority of the VOCs detected during the RI were found in shallow monitoring wells (MW-5S, MW-3S, and B-4S) and were BTEX compounds. The vertical extent of BTEX and chlorinated compound contamination is mostly confined to the upper 10 to 20 feet of the aquifer. Ethylbenzene, 1,1-DCA and chloroethane were detected, however, at depths up to 50 to 60 feet below the water table. The vertical extent of SVOC contamination is also mostly confined to the upper 10 to 20 feet of the aquifer. There were no SVOCs detected in any of the deep monitoring wells.

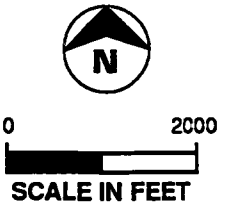
Monitoring wells along the southwestern edge of the landfill and southwest of the landfill exhibited the most occurrences of inorganic chemicals in concentrations above background levels. These are primarily shallow and medium wells that included MW-2S, MW-2M, MW-3S, MW-4S, MW-B4S, MW-5S, and MW-8S. Four chemicals, barium, iron, manganese, and sodium, were detected above background with greater frequency than the other inorganic chemicals. The higher concentrations of these four chemicals tend to occur in wells along the southwestern edge of the landfill or southwest of the landfill.

Record of Decision Goals

The ROD, signed August 14, 1990, defines the selected remedy and addresses the goals of the remedial action. The ROD goals and selected remedy are consistent with the RI/FS and Proposed Plan. The selected action for the remedy includes the following remedial actions for groundwater:

- Extraction and treatment of the groundwater contaminant plume to meet Federal Safe Drinking Water Act (SDWA) drinking water standards and State of Wisconsin groundwater quality standards
- Periodic monitoring of the groundwater contaminant plume
- Deed restrictions limiting surface and groundwater use at the Onalaska Municipal Landfill site





SOURCE: U.S. Geological Survey, Trempealeau, 15' Quadrangle.

FIGURE 1
SITE LOCATION MAP
ONALASKA
GWMP and QAPP

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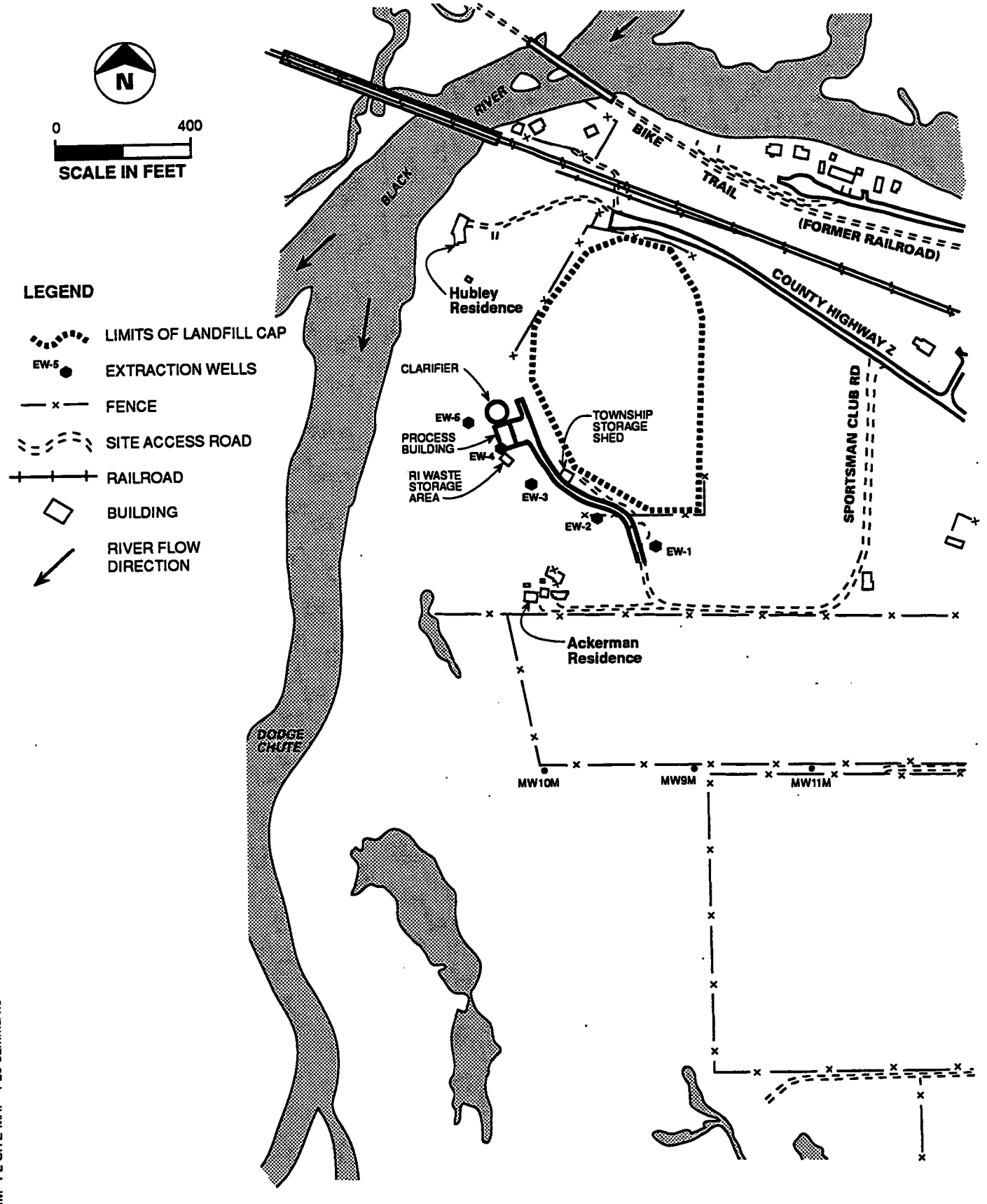

GL:O65602.DS.GM F2 SITE MAP 4-20-92mms/vls

FIGURE 2
SITE MAP
ONALASKA LANDFILL
GWMP and QAPP

- Continued reliance on state institutional controls governing groundwater use within the proximity of landfills

The groundwater remedial action goals stated in the ROD are to achieve Federal drinking water standards under the SDWA (Maximum Contaminant Levels [MCLs] or non-zero Maximum Contaminant Level Goals [MCLGs]) and the more stringent State of Wisconsin groundwater quality standards under Ch. NR 140, Wisconsin Administrative Code (Preventive Action Limits [PALs]).

The MCLs and non-zero MCLGs must be met at the landfill waste boundary and the more stringent Wisconsin standards (PALs) must be met at any point beyond the property boundary or the design management zone (DMZ).

If, after a minimum of 5 years of operation, it becomes apparent that it is technically or economically infeasible to achieve a Wisconsin PAL, then a Wisconsin alternative cleanup standard (WACL) may be considered.

If it becomes apparent that it is technically impractical to achieve the groundwater cleanup standards, including any WACL established, then alternate methods of controlling the groundwater plume or source would be considered. If those alternate methods are not able to attain the groundwater cleanup standards or WACL, then a Comprehensive Environmental Response and Compensation Liability Act (CERCLA) waiver may be considered.

Purpose

The purpose of this plan is to recommend procedures for periodic monitoring of the groundwater, surface water, and sediments over time. Periodic monitoring is necessary to verify that the groundwater collection system is containing the contaminated groundwater and preventing its migration, to evaluate whether adjacent wetlands and river are being impacted from the extraction of groundwater, and to determine whether the system is reducing the level of contaminants in the plume.

This plan discusses the following:

- Well monitoring network
- Groundwater sampling frequency at each well
- Groundwater Cleanup Standards
- Compounds to be analyzed for
- Supplementary sampling of adjacent surface water and sediments

- Sampling procedures, analytical programs, methods of analyses, Quality Assurance/Quality Control (QA/QC) protocols for CLP analyses
- Procedures for field measurements
- Reporting procedures
- Quality Assurance Project Plan (QAPP)
- Operation and Maintenance (O&M) of the wells

The guidelines presented in this groundwater monitoring plan are based on the best available information at the time of design and may not account for unanticipated field conditions. Therefore, the results of each data set collected shall be evaluated in the context of satisfying the intent of the ROD.

Sampling Rationale and Intended Data Use

The objectives of the groundwater monitoring program are to:

- Provide data to evaluate the effects of hydraulic gradient control and collection of contaminated groundwater within the aquifer
- Provide data to evaluate reduction of groundwater contaminant concentrations in the aquifer onsite in relation to associated cleanup criteria
- Provide data to evaluate reduction of groundwater contaminant concentrations in the aquifer offsite between the landfill and the Black River
- Monitor water levels in the wetlands adjacent to the site to ensure water levels are not lowered so as to adversely affect the wetlands.

These data shall be used to evaluate the effectiveness of the remedial action design and determine when groundwater extraction may cease.

Groundwater Monitoring Network

The groundwater monitoring network was designed to provide groundwater quality data for the site and adjacent area and is comprised of wells constructed during the RA and during the RI. The groundwater monitoring network consists of six new

water table piezometers, one new monitoring well, six existing monitoring wells, and five new extraction wells. The selected monitoring wells are primarily located hydraulically downgradient to the south, southeast, and west of the landfill site. One monitoring well is located upgradient of the landfill to provide background groundwater quality. The rationale for selection of each well and piezometer is summarized in Table 1. These wells will permit evaluation of the hydraulic gradient control and groundwater quality in the aquifer. Well and piezometer locations are shown in Figure 3.

Piezometers

Six piezometers were installed for the purposes of determining the impact of groundwater pumping on the wetlands area to the south of the site, and to ensure that the plume of contaminated groundwater is being captured by the system of extraction wells. Potential adverse impacts on the wetlands will be evaluated using pre- and post-pumping groundwater elevation data collected at the two piezometers (PZ-03 and PZ-04) located in the wetlands area. Plume capture will be determined by the horizontal hydraulic gradients, as defined by the water table elevations in the piezometers and in the monitoring wells, such as MW-14S, which is located near the edge of the plume. Two piezometers (PZ-01 and PZ-05) have been located just inside the plume, and two piezometers (PZ-02 and PZ-06) have been located just outside the plume to measure gradient at the plume boundary. The rate of groundwater pumpage can be varied to provide the groundwater gradients necessary to capture the plume.

Monitoring Wells

The monitoring wells (MW-1S, MW-6S, MW-6M, MW-8S, MW-8M, MW-12S and MW-14S) shall be used to monitor:

- If contaminated groundwater has been captured successfully (contaminants of concern are below action levels at point of compliance)
- Groundwater quality changes downgradient of the collection system capture zone (i.e., how quickly concentrations of contaminants of concern decrease after the extraction system is functioning)
- Hydraulic gradient control (contaminated groundwater plume is moving toward the extraction wells)

Groundwater quality downgradient of the landfill and extraction well network will be monitored in shallow wells MW-6S (new) and MW-8S and in intermediate wells MW-6M and MW-8M. These well locations were selected to place wells outside of

the capture zone. MW-12S and MW-14S are located on the periphery of the capture zone and will be used to monitor groundwater quality and hydraulic gradient control east and west of the extraction well network. MW-1S will be used to monitor background groundwater quality upgradient of the landfill.

Monitoring using only shallow and intermediate wells is proposed. The majority of the VOCs detected during the Remedial Investigation were found in shallow monitoring wells (MW-5S and former wells MW-3S and B4S). The vertical extent of BTEX and chlorinated compounds contamination is mostly confined to the upper 10 to 20 feet of the aquifer. Ethylbenzene, 1,1-DCA and chloroethane were detected, however, at depths up to 50 to 60 feet below the water table. The vertical extent of semivolatile organic compounds (SVOCs) contamination is also mostly confined to the upper 10 to 20 feet of the aquifer. There were no SVOCs detected in any of the deep monitoring wells.

To verify that groundwater contaminants are not migrating vertically to lower depths, MW-2D will be sampled periodically for VOCs.

Extraction Wells

A series of five extraction wells have been installed in locations that capture the contaminant plume prior to offsite groundwater discharge. The extraction well network has been designed to extract approximately 800 gallons per minute (gpm) of contaminated groundwater for treatment. This pumping rate was estimated based on a pump test conducted in April of 1991. The rate of pumpage for each well can be varied during operation, based on results of monitoring wells and piezometers. Groundwater from the extraction wells will be monitored to assess the degree that contaminant cleanup is occurring.

Piezometers

Six shallow water piezometers were installed to monitor hydraulic gradient control during the remedial action. Groundwater elevation data will be collected monthly from the six piezometers. A summary of water levels measured for the monitoring wells during the remedial investigation is provided in Attachment 1.

Potential Additional Monitoring for Compliance with Groundwater Standards

The expected reduction in contaminant concentrations within the plume capture zone will be monitored by sampling the five extraction wells. If the contaminant concentrations in these wells decline to the groundwater cleanup standards, wells along the landfill waste boundary would require monitoring. The additional wells to be monitored are shown in Figure 3 and include MW-4S and MW-5S. These wells

Table 1
Monitoring Well Network Rationale
Sheet 1 of 2

Well Designation	Rationale
PZ-01	Monitor groundwater level west of westernmost extraction well to determine if necessary capture zone is being attained
PZ-02	Monitor groundwater level between wetlands and extraction system to determine if wetlands water levels are being lowered
PZ-03	Monitor groundwater level between wetlands and extraction system to determine if wetlands water levels are being lowered
PZ-04	Monitor groundwater level between wetlands and extraction system to determine if wetlands water levels are being lowered
PZ-05	Monitor groundwater level east of easternmost extraction well to determine if necessary capture zone is being attained
PZ-06	Monitor groundwater level east of easternmost extraction well to determine if necessary capture zone is being attained
MW-1S	Monitor shallow background groundwater quality upgradient of the landfill and the extraction system to determine if reduction in groundwater concentration occurs over time
MW-6S	Monitor shallow groundwater quality and water levels downgradient of landfill and extraction system to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)
MW-6M	Monitor intermediate groundwater quality and water levels downgradient of landfill and extraction system to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)
MW-8S	Monitor shallow groundwater quality and water levels downgradient of landfill and extraction system to determine if contaminated groundwater has been captured (compliance point for Wisconsin PALs)

Table 1 Monitoring Well Network Rationale Sheet 2 of 2	
Well Designation	**Rationale**
MW-8M	Monitor intermediate groundwater quality and water levels downgradient of landfill and extraction system to determine if contaminated groundwater has been captured (compliance point for Wisconsin PALs)
MW-12S	Monitor shallow groundwater quality and water levels east of easternmost extraction well to determine if necessary capture zone is being attained and whether contaminated groundwater has been captured (compliance point for Wisconsin PALs)
MW-14S	Monitor shallow groundwater quality and water levels west of westernmost extraction well to determine if necessary capture zone is being attained and whether contaminated groundwater has been captured (compliance point for Wisconsin PALs)
EW-1	Groundwater extraction well—water quality monitored to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)
EW-2	Groundwater extraction well—water quality monitored to determine if reduction in groundwater concentration occurs over time
EW-3	Groundwater extraction well—water quality monitored to determine if reduction in groundwater concentration occurs over time
EW-4	Groundwater extraction well—water quality monitored to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)
EW-5	Groundwater extraction well—water quality monitored to determine if reduction in groundwater concentration occurs over time (compliance point for Wisconsin PALs)

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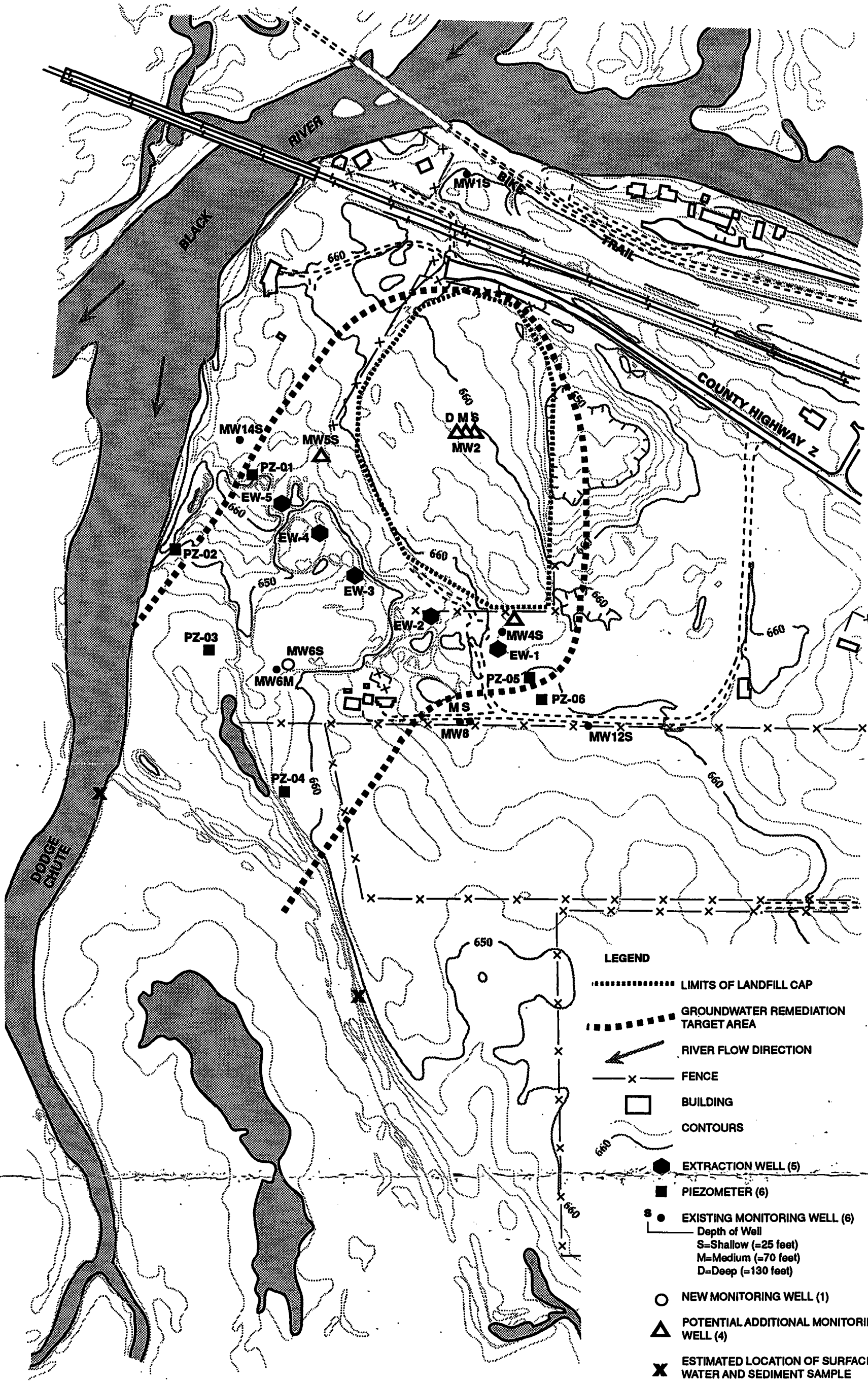

FIGURE 3
MONITORING WELL, EXTRACTION WELL, AND PIEZOMETER NETWORK
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GWMP and QAPP

represent the compliance point defined in the ROD (the landfill waste boundary) for MCLs and non-zero MCLGs. The compliance point for the PALs (any point beyond the property boundary or DMZ) are represented by monitoring wells MW-4S, MW-6S, MW-6M, MW-8S, MW-8M, MW-12S, and MW-14S and extraction wells EW-1, EW-4, and EW-5. The groundwater standards and compliance points are discussed in more detail later in this document.

Surface Water and Sediments

The groundwater beneath the site generally flows in a south-southwesterly direction toward the wetlands bordering the Black River. Although no site-derived contamination was detected in the surface water and sediment samples collected during the Remedial Investigation (RI), surface water and sediments will be sampled annually to monitor for potential offsite contaminant migration during performance of the remedial action. Surface water and sediment grab samples will be collected from the wetland area and Dodge Chute. Sample locations are shown in Figure 3.

Sampling Schedule and Frequency

The groundwater monitoring plan includes monthly and quarterly sampling events from monitoring wells and extraction wells, and collection of monthly groundwater elevation data from the six piezometers. In addition, annual surface water and sediment samples will be collected from two locations. All surface water and sediment samples will be collected in triplicate from each of the two locations during each sampling event.

The sampling schedule will be evaluated annually and adjusted as needed depending on the analytical results and the operation of the extraction and treatment system. The frequency of sampling will be re-evaluated annually. The sampling plan is described below.

Monthly Sampling

Monthly groundwater samples will be collected during the first year of system operation. The primary purpose of the monthly sampling is to monitor the efficacy of the newly-implemented groundwater extraction and treatment system and identify needed refinements and corrections. Monthly groundwater samples and elevation data will be collected from the five extraction wells (EW-01 through EW-05) and six monitoring wells (MW-06S, MW-06M, MW-08S, MW-8M, MW-12S, and MW-14S) during the first year of remedy implementation. Monthly elevation data also will be collected from the six piezometers and all existing onsite monitoring wells for the first year.

The monthly groundwater level measurements and groundwater samples will be collected during the first week of each month. The sampling schedule will be revised to quarterly sampling after the first year of monthly sampling and system evaluation unless unanticipated problems warrant continued monthly sampling. Monthly readings of groundwater elevations in the piezometers and extraction wells will continue for the duration of groundwater extraction. The frequency of these readings will be re-evaluated annually.

Quarterly Sampling

The primary purpose of the quarterly sampling is to continue to evaluate the groundwater extraction and treatment system for reliable operation and monitor the reduction of contaminant concentrations in the aquifer. The quarterly sampling will also identify any seasonal fluctuations in groundwater quality.

Quarterly sampling will commence at the beginning the second year and continue through the fifth year of system operation. Elevation measurements from the piezometers, monitoring wells and extraction wells will continue to be collected on a monthly basis. Groundwater samples and elevation measurements from the six monitoring wells and five extraction wells will be collected during the first week of March, June, September, and December.

The need for elevation data from the other existing monitoring wells will be evaluated after the first year. Depending on the analytical results from the quarterly sampling and the absence of operational problems, the sampling schedule may be modified further.

After 5 years of operation of the groundwater extraction and treatment system, the groundwater quality will be evaluated to determine if the groundwater standards have been met. In addition to the evaluation of results of quarterly samples collected over the 5-year period, a full priority pollutant scan will be performed to determine if additional parameters should be added to the compounds listed in Table 2. If the groundwater goals (or WACLs, if established) have not been met, sampling will continue until the cleanup goals are achieved. The frequency of sampling will be evaluated based on the trends observed in the first 5 years. If an applicable and appropriate requirements (ARAR) waiver is established, the groundwater goals and the need or frequency of further sampling will be addressed as part of the waiver process.

Annual Surface Water and Sediment Sampling

Annual surface water samples will be collected from the two locations shown in Figure 3. Sediment samples will be obtained from the same locations as the surface water samples. The primary purpose of these samples is to monitor for any unusual

increase in contaminant concentrations that may be attributed to remedy implementation activities.

Analytical Procedures

Groundwater samples from the monitoring and extraction wells will be analyzed for the compounds listed in Table 2. The list is comprised of compounds identified in the ROD as the "Chemicals of Concern" and are listed in Table 3B of the ROD. These compounds are the groundwater cleanup standards required by the ROD. In addition, the following compounds have been added to the ROD list in Table 2:

- Chloride and total dissolved solids (TDS) analyses will be used to indicate the relative strength of the leachate contributed by the landfill
- Total organic carbon (TOC) analyses will be used to evaluate the organic strength of the leachate and help to monitor the diminishing contaminant concentrations in the plume
- Oil and Grease analyses will be used to monitor for the presence of the nonaqueous phase detected in the RI
- Alkalinity, hardness (total as $CaCO_3$), iron, chemical oxygen demand (COD), specific conductance, manganese, color, and turbidity. These analyses are required by the WDNR for monitoring of groundwater downgradient from sanitary landfills. These parameters will be used to comply with WDNR reporting requirements and are indicative of the amount of leachate entering the groundwater.

Groundwater, surface water, and sediment samples will be analyzed for the listed compounds using the CLP's special analytical services (SAS) for volatile organic compounds (VOCs) and inorganic constituents. SASs will also be provided for the following conventional parameters: chloride, TOC, TDS, oil and grease, alkalinity, hardness, COD, color, and turbidity. Field temperature, pH, and specific conductance will also will be recorded for each well during sampling events. Field sampling procedures, methods of analyses, and QA/QC protocols for CLP analyses will be conducted in accordance with the QAPP. An outline of the QAPP is presented in Appendix C.

Groundwater Cleanup Standards

Under the remedy selected in the ROD, the following cleanup standards were adopted:

Table 2
Groundwater Monitoring Analyte List
and Action Levels

Target Analytes	PAL (µg/L)	MCL (µg/L)	MCLG (µg/L)	Detection Limit[a] (µg/L)
ROD Compounds				
Benzene	0.067	5		10
Toluene	68.6	1,000[b]	1,000[b]	10
Xylenes	124		10,000	10
Ethylbenzene	272		1,000	10
Trichloroethene	0.18	700[b]	700[b]	10
1,1-Dichloroethane	85			10
1,1,1-Trichloroethane	40	200		10
1,1-Dichloroethene	0.024	7		10
Arsenic	5	50		10
Barium	0.2	2,000	2,000	200
Lead	5	15[c]	0.0	3
Others[d]				
Chloride	125			2,000
Total Organic Carbon (TOC)	1			
Total Dissolved Solids (TDS)	200			
Oil and Grease	None			

[a] Based on RAS detection limits. SAS limits to be defined when QAPP is finalized.
[b] Standard effective July 30, 1992.
[c] Standard effective December 7, 1992.
[d] Units for Other Analytes in mg/L.

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- Groundwater contaminant plume located at any point beyond the property boundary or DMZ:
  - Preventive Action Limits (PALs) from Wisconsin Administrative Code Chapter NR 140
- Groundwater contaminant plume located at landfill waste boundary:
  - Maximum Contaminant Levels (MCLs) from the Safe Drinking Water Act, 40 CFR 141.61 and 40 CFR 143
  - Maximum Contaminant Level Goals (MCLGs) above zero Safe Drinking Water Act, 40 CFR 141.50

The ROD requires that the more stringent Wisconsin standards promulgated in NR 140, WAC, be achieved "at any point beyond the property boundary or beyond the 3-dimensional design management zone, whichever is closer to the waste boundary." The DMZ as defined in NR 140 is a 3-dimensional boundary surrounding a regulated facility. The boundary extends from the ground surface through all saturated geological strata. The DMZ defined for the Onalaska site extends 250 feet horizontally from the waste boundary as shown in Figure 3. Because the property boundary generally is closer to the waste boundary than to the DMZ, the property boundary is considered the point at which PALs apply. As the plume is reduced in size, however, the MCLs or MCLGs could apply.

The monitoring wells included in the groundwater monitoring network are located beyond the waste boundary shown in Figure 3. The analytical results from the groundwater samples will be compared to the groundwater contaminants of concern listed in Table 2.

After a minimum of 5 years of groundwater extraction and treatment, the ROD requires an evaluation to determine if the remedial action objectives are being met. If it is determined after 5 years of implementation of the remedial action that PALs cannot be met feasibly, a Wisconsin alternative concentration limit (WACL) may be proposed.

Data Analysis and Evaluation

Background Monitoring

Background groundwater quality will be measured in monitoring well MW-01S located upgradient of the landfill. Background monitoring will be conducted during seasonal high and low groundwater levels as indicated by historical groundwater level

data and concurrent piezometer water elevation. Background concentrations from groundwater will be established by averaging eight sample results from the background well. Four samples will be collected during the seasonal high water level, and four during the seasonal low water level. The eight samples will be collected from the background well once every 5 years and analyzed for the same parameters as the other groundwater samples. Background concentrations for each parameter analyzed will be the statistical mean of the analytical results plus three standard deviations. The background concentrations will be evaluated to determine if regional groundwater quality exceeds PALs. If background concentrations exceed PALs, background results will be used in lieu of PALs to evaluate if remedial action goals have been achieved.

Baseline Monitoring

Baseline monitoring will be conducted prior to commencement of the remedial action after all new wells have been installed and developed. Three discrete samples will be collected and analyzed from each of the 12 wells in the monitoring program to develop baseline concentrations. In addition, the five monitoring wells along the landfill waste boundary will be sampled for baseline monitoring. Results from the baseline analyses will be used to establish initial conditions and spatial variability of quality in the sampled groundwater.

Each sample will be a separate and distinct sample taken in accordance with the sampling procedures specified in the QAPP.

The mean, variance, standard deviation, and 95-percent confidence limits of the mean will be calculated for all compounds analyzed for each well. These data will be used for the initial database to assess any future trends. The analytical results will be compared to background concentrations. Compounds that are detected above background concentrations will be compared to the Wisconsin PALs, MCLs, and MCLGs shown in Table 2.

Monthly/Quarterly Monitoring and Evaluation

Monthly samples will be analyzed for the SAS VOCs, inorganic constituents and conventional parameters, and RAS lead. Results from these analyses will be compiled and used to assess the implementation, operation, and maintenance of the groundwater extraction and treatment system, and to troubleshoot and improve system operation. At the end of the first year of sampling, all monthly data will be compiled and compared to the groundwater standards shown in Table 2 and evaluated for changes in aquifer contaminant concentrations.

After each quarterly sampling round, the analytical results from each well will be compiled and used to monitor aquifer concentrations and evaluate the performance

of the groundwater extraction and treatment system. These data will be used to identify and implement any corrective action required to maintain reliable operation. At the end of each year of quarterly sampling, the analytical results will be compiled and compared to the groundwater standards shown in Table 2 and evaluated for changes in the aquifer contaminant concentrations in the aquifer. Current Wisconsin DNR guidance [2] on methods for calculating compliance with groundwater quality regulations will be used to prepare these comparisons and evaluation of changes in concentrations.

Annual Evaluation of Quarterly Results

The quarterly results of the sampling and analysis program will be compiled annually. The analytical results will be averaged and the data evaluated to examine spatial and temporal trends. This analysis will also include monthly piezometer readings. The types of spatial and temporal trends conducted will be evaluated after each year of sampling. Initially, the analysis will include:

- Plots of mean concentration versus time for each parameter analyzed for the individual wells
- Plots of concentration versus time of moving averages for each parameter analyzed for individual wells
- Regression analyses on plots of moving average concentration versus time to determine direction of trends

The entire monitoring program also will be reevaluated annually. Specific adjustments to the program that may be necessary include:

- Analyte list—Do analytes need to be added or deleted?
- Sampling frequencies—Is quarterly sampling (and monthly piezometer readings) adequate or excessive?
- Monitoring well network—Is the monitoring well network adequate? Does any well need to be replaced? Should additional wells be installed? Can some of the monitoring wells be deleted from the sampling program?
- Sampling program—Do the analytical data indicate that the overall concentrations are decreasing? Should the monitoring program continue?

At the end of the fifth year, all sampling results will be compiled. These analytical results will be averaged and evaluated for temporal trends. Compound concentrations will be compared with groundwater standards and evaluated.

Sampling Equipment and Procedures

General procedures for measuring water levels, performing field tests, and collecting water quality samples are described below. Additional details related to specific sampling and decontamination procedures, sampling frequencies, and analytical requirements are discussed in the QAPP (the QAPP outline is shown in Appendix C).

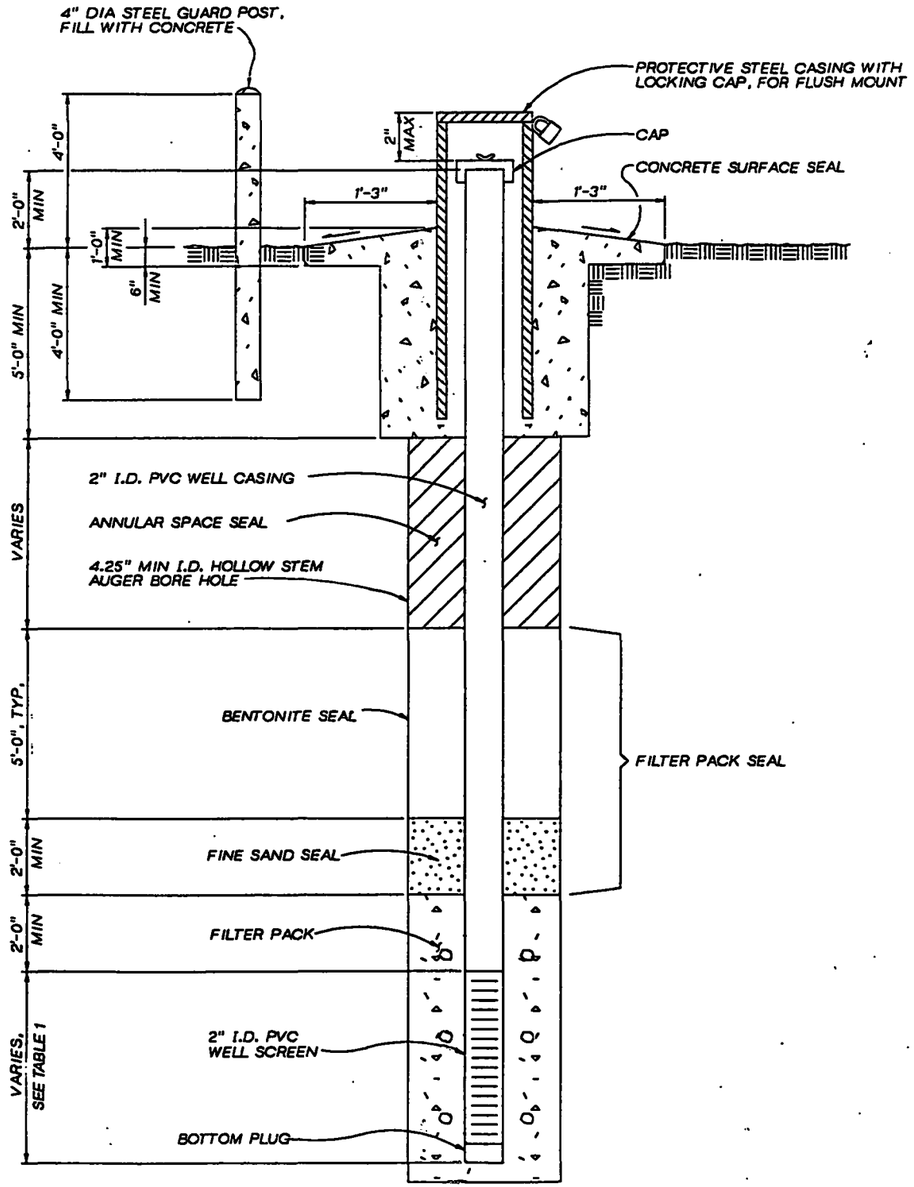
All wells will be sampled using the same equipment and procedures. Wells installed during the remedial investigation were constructed using both PVC and stainless steel riser and screens. The single well and six piezometers installed during remedial action will be constructed using 2-inch Schedule 40 PVC. Typical well and piezometer construction details are shown in Figure 4.

All surface water and sediment samples will be collected using the equipment identified below.

Field Equipment

The following equipment is required to sample the wells:

- Equipment needed to open the wells
  - Key to unlock wells
  - Organic vapor detector (HNu or OVA)
- Equipment for measuring water levels
  - Electronic water level indicator
- Equipment for purging wells
  - Dedicated teflon tubing bundles
  - Portable generators to operate purging pumps
  - Dedicated purging and sampling pumps
  - Buckets or containers of known volume to measure purge water quantity



TYPICAL WELL SECTION DETAIL
NTS

ABBREVIATIONS

FMC = FLUSH MOUNT COVER

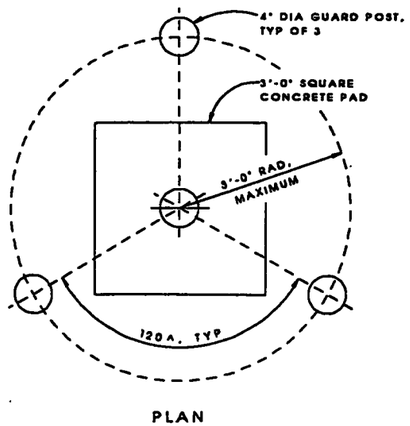
PSC = PROTECTIVE STEEL CASING

NOTE:

1. MONITORING WELL DEPTHS AND INSTALLATION DETAILS SHOWN ARE APPROXIMATE AND/OR ESTIMATED. ACTUAL DEPTHS AND FINAL INSTALLATION DETAILS WILL BE DETERMINED BY THE ENGINEER IN THE FIELD.

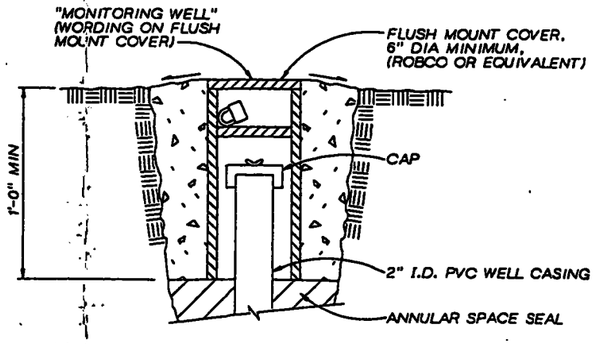
TABLE 1
PIEZOMETER AND MONITORING WELL DEPTHS AND INSTALLATION DETAILS

MONITORING WELL NUMBER	APPROXIMATE TOTAL DEPTH (FT)	APPROXIMATE WELL CASING LENGTH (FT)	WELL SCREEN LENGTH (FT)	TYPE OF PROTECTIVE COVER
PZ-01	30	20	10	PSC
PZ-02	30	20	10	PSC
PZ-03	30	20	10	PSC
PZ-04	30	20	10	PSC
PZ-05	30	20	10	PSC
PZ-06	30	20	10	PSC
MW-65	30	20	10	PSC



PLAN

CONCRETE PAD AND GUARD DETAIL
NTS



FLUSH MOUNT DETAIL
NTS

FIGURE 4
PIEZOMETER AND MONITORING WELL CONSTRUCTION DETAILS
ONALASKA LANDFILL GM

GLO5602.DS.GM F5 BORDER 1-27-92mms

- Flow control box

- Sample collection and field testing equipment
  - Dedicated sampling pumps
  - Sample containers with preservatives and labels provided by the analytical laboratory
  - Ice chest, ice
  - Thermometer (0° to 50°C range)
  - Conductance and pH meter
  - Groundwater quality field test data sheets
  - Decontamination solutions, containers, brushes, etc.

- Sample Records
  - Daily activity logs and field notebooks
  - Laboratory log sheets and chain-of-custody forms

The following equipment is required to sample the surface water and sediments:

- Equipment needed to sample surface water
  - Clean glass or stainless steel beaker
  - Sample containers

- Equipment needed to sample sediments
  - Uncoated scoop for sample collection
  - Stainless steel spoon for media transfer to sample container
  - Sample containers

Description of Monitoring Well Equipment

All monitoring wells are equipped with dedicated sampling equipment for use in the long-term monitoring program. Each monitoring well is installed with a positive gas displacement bladder pump constructed so no gas or liquid is introduced into the well or sample during the pumping operation. The pumps are fabricated of Type 316 stainless steel with a Teflon bladder. Bladders are field replaceable. Pumps are fitted with an inlet screen fabricated of Type 316 stainless steel and Type 316

stainless steel fittings and hardware for connection of sample discharge and supply tubing.

Teflon tubing bundles are provided for each pump. The tubing bundles, which are sized to match the bladder pump, consist of an air supply line and water sample line that are bonded together.

Each wellhead assembly has a quick-connect fitting for attachment of the air supply line from the air source to the air supply line of the pump. Each wellhead assembly also has a quick-connect-type fitting and discharge line for water discharge to a sample container. Wellheads are installed with a port to allow use of a portable water level indicator and other downhole sensors.

A portable cart is provided for the air compressor, engine, and pump controller for transport to each well during sampling. The adjustable controller is housed in an environmentally-sealed, shock-resistant enclosure. It is powered internally and capable of 12 hours of continuous operation. The oil-less air compressor is capable of supplying air to the controller and pump at a minimum 100 pounds per square inch (psi) and 4.5 standard cubic feet per minute. It is powered by a clean-running gasoline engine.

A field kit is provided that consists of spare parts and tools for routine maintenance of the pumps and other equipment. The kit includes tools and materials needed for field replacement of pump bladders.

Calibration

The calibration procedures and frequency of calibration for field equipment are provided in Appendix D.

Preventive Maintenance

Well Covers and Protection

The well covers and surface protection (bumper posts) require minimum maintenance. The protective steel casings require periodic painting to prevent rusting. Damaged locks on well covers will be replaced as needed. Damaged concrete surface pads around wells will be repaired or replaced as needed.

Field Equipment

Each piece of field equipment will be tested prior to each use to verify it is in proper working order before it is sent to the site. Only properly-working equipment will be

sent to the site. The instrument operator's manual will dictate the frequency of calibration and maintenance.

Groundwater Sampling and Measurements

Each well consists of a 2-inch-diameter Schedule 40 PVC well riser and well screen. The general sampling procedures and sequence described below are recommended as a guide to sampling each well. Groundwater measurements and sampling will proceed in the following sequence:

1. Organize and decontaminate sampling equipment and calibrate instruments

2. Remove padlock

3. Open well cover and remove well riser cap

4. Monitor inside well casing with an organic vapor detector

5. Measure and record static water level relative to top of casing per procedures summarized below (see Groundwater Elevation Measurements)

6. Calculate and record the volume of water in the well in accordance with the following formula:

   - Wellbore water volume = $\pi \times r^2 \times h$,

     where h = height of water column
     r = radius of well bore

   (Note: Units must be consistent in all calculations)

7. Purge well per procedures summarized below (see Procedures to Purge Wells)

8. Perform field analyses; record pH, specific conductance and temperature readings

9. Collect water samples per procedures outlined below (see Water Sample Collection Procedures)

10. Preserve samples for storage and laboratory analyses

11. Complete sample records and chain-of-custody forms and seals

12. Ship samples via overnight courier to analytical laboratory

Groundwater Elevation Measurements

Determine the depth to water in the well to the nearest 0.01 foot using an electronic water level indicator. When the electrode or probe comes into contact with the water, an electrical circuit is completed, activating the meter light and beeper. Determine the depth of water using the following steps:

1. Lower the electrode or probe into the well by pulling the cable from the hand-held reel.

2. Continue lowering until completion of the circuit is indicated by illumination of the small light, a beep, or deflection of the ammeter needle.

3. Measure the length of cable in the well from the marked edge on the top of casing to the probe (depth to the water table) to the nearest 0.01 foot and subtract this length from the top of the casing elevation to determine the water table elevation.

4. Record depth on Groundwater Sampling Field Data Record sheet (shown in Figure 5).

Procedures to Purge Wells

Prior to sampling, wells will be purged by removing three to five standing water column volumes as calculated previously. The amount of purge water will be measured by filling and counting 5-gallon buckets. Disposal of purge water will follow procedures in the waste disposal plan discussed below.

Water Sample Collection Methods

Samples will be collected after the requisite volume has been purged from the well. Volatile organic analysis (VOA) vials will be filled first; containers for filtered metals will be filled last. In all cases, the samples will be collected directly from the discharge line. Collect VOA samples first—reduce volume of discharge from the pump sample line by adjusting the control box. Place the mouth of the VOA vial at the end of the discharge tube and allow bottle to fill slowly. Fill vial in a steady, gentle stream with a minimum of agitation. Fill until a meniscus forms on the mouth of the VOA vial. Cap vial and check for air bubbles by inverting vial and tapping on the palm of the hand. If bubbles are present, repeat procedure until a bubble-free sample is obtained.

GROUNDWATER SAMPLING FIELD DATA RECORD

GENERAL INFORMATION

SITE _____ WELL NUMBER _____

SAMPLE TEAM _____

WEATHER CONDITIONS _____

EQUIPMENT LOG

	Make/Model	Serial/ID No.	Calibration Date	Calibration Time	Calibration Initials	Comments
pH Meter						
Conductivity Meter						
Water Level Ind.						
Pump						

WELL CONDITION, ELEVATIONS/DEPTHS (1)

Locked Yes	Locked No	Comments (General Observations/Exceptions	Depth of Well Original	Depth of Well Current	Depth to Water	Elev. of Riser	Elev. of Water	Wellbore Water Volume (2)

PURGE INFORMATION

Date	Time	Volume (3)	Temp. (4)	pH (4)	Cond. (4)	HNu/OVA	Comments (Odor, Clarity, etc.)

SAMPLE INFORMATION

Date	Time	Sample Number	Comments (Include Modifications to QAPP/SP)

REMARKS

_____

Notes:

(1) All depths in feet from northern rim of the top of well riser, unless otherwise noted. All elevations in feet above mean sea level (N.G.V.D.), unless otherwise noted.

(2) Wellbore water volume = $\pi r^2 h$, where r=radius of well and h=height of water column for a 2-inch diameter well, volume=.022xh.

(3) Cummulative volume of water in feet.

(4) Readings required at least once for each wellbore water volume purged.

GLO65602.DS.GM GW SAMP Field DATA Form 1-29-92mms

FIGURE 5
FIELD SHEET
ONALASKA LANDFILL GM

Increase discharge rate and fill remaining sample containers to the shoulder. Before collecting filtered metals samples, attach an inline sample field filter directly to the pump discharge tube per manufacturer's instructions (Appendix D). Fill containers for metals analyses.

Sample Shipping

Coolers will be used to transport samples form the field to the analytical laboratory. Samples requiring preservation by cooling will be kept cold and uniform at all times.

All shipments will be accompanied by a chain-of-custody record identifying the contents. The original record will accompany the shipment, and a copy will be retained by the sampler.

The copy of the airbill accompanying each shipping container will be retained as part of the permanent documentation. Commercial carriers are not required to sign the custody form as long as the custody forms are sealed inside the sample cooler and the custody seals remain intact.

Waste Disposal

Wastes generated during sampling will consist of well purge water, wastes from decontamination, and protective clothing. Prior to operation of the groundwater treatment system, the following procedure will be followed.

If HNu reading (or equivalent photoionization device) exceeds 1 ppm, purge water from wells and associated decontamination water will be collected in 55-gallon drums approved by the U.S. Department of Transportation. If HNu headspace readings are less than 1 part per million (ppm), purge water will be discharged to the ground. If additional sampling rounds indicate groundwater is contaminated with compounds at concentrations that exceed Federal MCLs, the purge water from the specified well and associated decontamination water will be collected in 55-gallon drums. The drums will be labeled and staged temporarily onsite in a controlled-access area. Once the groundwater treatment system is in operation, all purge water exceeding the 1-ppm criteria, including purge water previously stored in drums, will be treated in the onsite groundwater treatment system.

Decontamination

Where groundwater has made contact with field equipment used in well sampling (i.e., water level indicator probe, pH probe, specific conductance, and temperature probes) will be decontaminated between wells with a TSP and distilled water solution, followed by a 10 percent methanol and distilled water solution, followed by a distilled

water rinse. At the conclusion of the sampling event, sampling equipment will be decontaminated again with this procedure.

Corrective Action

Field Corrections

Deviations from routine procedures and subsequent corrective measures will be documented in a field log book and reported to the appropriate agency. Because possible deviations are dependent upon unknown field conditions, corrective measures cannot be specified. For field measurements, the corrective action must be suited to the situation and may include:

- Repetition of measurement to check the error
- Checking batteries
- Recalibration of the instrument
- Replacement of the instrument

Reporting

Quarterly

The quarterly report will consist of a Technical Memorandum (TM) to the U.S. EPA and Wisconsin Department of Natural Resources. The major components of the report will be:

- Date and time of the monthly sampling events
- Personnel involved in the sampling event(s) and their respective responsibilities
- List of the wells sampled during the event or monthly events
- Summary of the procedures used during the sampling event, including any noted deviations
- List of pertinent observations taken during the sampling events
- Summary of the analytical data with QA/QC qualifiers
- List of contaminants of concern detected and their concentrations

- Comparison of results to groundwater standards
- Data table of groundwater elevation data

The TM will be delivered within 30 days following receipt of all analytical data and QA reviews.

Annual

The annual report to the U.S. EPA and Wisconsin Department of Natural Resources will consist of:

- Date and time of the sampling events
- Personnel involved in the sampling events and their respective responsibilities
- List of the wells sampled during the event
- Summary of the procedures used during the sampling event, including any deviations from standard procedures
- List of pertinent observations taken during the sampling event
- Summary of the analytical results received from the laboratory and the validated results
- Comparison of the initial database with analytical results
- Temporal and spatial trends of the contaminant plume concentrations
- A summary of average concentrations (for each well) for the contaminants of concern
- Recommendations of changes to monitoring program including additions to the contaminants of concern
- Appendix containing quarterly TMs
- Appendix addressing the analytical data and the QA/QA evaluations of the laboratory data

Data attachments to the annual report will include:

- Data validation report

- Chain-of-custody forms
- Data table of compiled potentiometric values (groundwater elevation measurements) for all monitoring wells
- Field parameter sheets
- Potentiometric surface map (groundwater contour map) drawn using the potentiometric values collected during the sampling event

The annual report will be delivered within 60 days after receipt of all analytical data and quality assurance (QA) reviews for the annual sampling round. The reports for the quarterly and semi-annual sampling rounds will be delivered separately within the reporting period, and also will be incorporated into the annual report.

References

[1] *Draft Operation and Maintenance Manual, Groundwater Treatment Remedial Action.* CH2M HILL. May 1992.

[2] *Methods for Determining Compliance with Groundwater Quality Regulations at Waste Disposal Facilities.* Wisconsin Department of Natural Resources. January 1989.

GLT272/058.51

APPENDIX A
GROUNDWATER QUALITY STANDARDS WISCONSIN ADMINISTRATIVE CODE NR 140

Chapter NR 140

GROUNDWATER QUALITY

Subchapter I — General

NR 140.01 Purpose. The purpose of this chapter is to establish groundwater quality standards for substances detected in or having a reasonable probability of entering the groundwater resources of the state; to specify scientifically valid procedures for determining if a numerical standard has been attained or exceeded; to specify procedures for establishing points of standards application, and for evaluating groundwater monitoring data; to establish ranges of responses the department may require if a groundwater standard is attained or exceeded; and to provide for exemptions for facilities, practices and activities regulated by the department.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85.

NR 140.03 Applicability. This subchapter and subch. II apply to all facilities, practices and activities which may affect groundwater quality and which are regulated under ch. 85, 93, 94, 101, 144, 145, 146 or 147, Stats., by the department of agriculture, trade and consumer protection, the department of industry, labor and human relations, the department of transportation, or the department of natural resources, as well as to facilities, practices and activities which may affect groundwater quality which are regulated by other regulatory agencies. Health-related enforcement standards adopted in s. NR 140.10 also apply to bottled drinking water manufactured, bottled, sold or distributed in this state as required by s. 97.34 (3) (b), Stats., and to determining eligibility for the well compensation program under s. 144.027, Stats. Subchapter III applies to all facilities, practices and activities which may affect groundwater quality and which are regulated by the department under ch. 144, 146 or 147, Stats. This chapter does not apply to any facilities, practices or activities on a prospecting site or a mining site because those facilities, practices and activities are subject to the groundwater quality requirements of chs. NR 131, 132 and 182. The department may promulgate new rules or amend rules governing facilities, practices or activities regulated under ss. 144.80 to 144.94, Stats., if the department determines that the amendment or promulgation of rules is necessary to protect pub-

lic health, safety or welfare. The requirements of this chapter are in addition to the requirements of any other statutes and rules.

Note: This chapter does not apply to public water systems except for the purpose of determining eligibility for well compensation as stated above. Chapter NR 109 contains maximum contaminant levels applicable to public water systems. Drinking water maximum contaminant levels and health advisory levels may take into account such factors as treatment costs and feasibility for public water systems.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85.

NR 140.05 Definitions. (1) "Accuracy" means the closeness of a measured value to its generally accepted value or its value based upon an accepted reference standard.

(1m) "Alternative concentration limit" means 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.

(2) "Attain or exceed" means that the concentration of a substance is determined to be equal to or greater than the preventive action limit or enforcement standard for that substance.

(3) "Background water quality" or "background concentration" means groundwater quality at or near a facility, practice or activity which has not been affected by that facility, practice or activity.

(4) "Certified laboratory" means a laboratory which performs tests for hire in connection with a covered program and which receives certification under s. 144.95 (7), Stats., or receives reciprocal recognition under s. 144.95 (5), Stats.

(5) "Department" means the department of natural resources.

(6) "Design management zone" means a 3-dimensional boundary surrounding each regulated facility, practice or activity established under s. NR 140.22 (5).

(7) "Enforcement standard" means a numerical value expressing the concentration of a substance in groundwater which is adopted under s. 160.07, Stats., and s. NR 140.10 or s. 160.09, Stats., and s. NR 140.12.

(8) "Facility, practice or activity" means any source or potential source of a substance which is detected in or has a reasonable probability of entering the groundwater resources of the state.

(9) "Groundwater" means any of the waters of the state, as defined in s. 144.01 (19), Stats., occurring in a saturated subsurface geological formation of rock or soil.

(10) "Indicator parameter" means a substance for which a preventive action limit has been established under s. NR 140.20, which is used to indicate the potential for a preventive action limit established under s. NR 140.10 or 140.12 to be attained or exceeded and for which an enforcement standard has not been established under s. NR 140.10 or 140.12.

(11) "Land disposal system" means a facility for disposing of liquid wastes consisting of:

(a) An absorption or seepage pond system,

(b) A ridge and furrow system;

(c) A spray irrigation system,

(d) An overland flow system,

(e) A subsurface field absorption system,

(f) A land spreading system, or

(g) Any other land area receiving liquid waste discharges.

(12) "Limit of detection" means 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.

(13) "Limit of quantitation" means the lowest concentration for an analytical test method and sample matrix at which the quantity of a particular substance can be measured with a stated degree of confidence.

(14) "Monitoring" means all procedures used to collect data on groundwater, surface water or soils.

(15) "Point of standards application" means the specific location, depth or distance from a facility, activity or practice at which the concentration of a substance in groundwater is measured for purposes of determining whether a preventive action limit or an enforcement standard has been attained or exceeded.

(16) "Precision" means the closeness of repeated measurements of the same parameter within a sample.

(17) "Preventive action limit" means a numerical value expressing the concentration of a substance in groundwater which is adopted under s. 160.15, Stats., and s. NR 140.10, 140.12 or 140.20.

(18) "Property boundary" means the boundary of the total contiguous parcel of land owned or leased by a common owner or lessor, regardless of whether public or private roads run through the parcel.

(19) "Registered laboratory" means a laboratory which is registered under s. 144.95 (8), Stats., or receives reciprocal recognition under s. 144.95 (5), Stats.

(20) "Regulatory agency" means the department of agriculture, trade and consumer protection, the department of industry, labor and human relations, the department of transportation, the department of natural resources and other state agencies which regulate activities, facilities or practices which are related to substances which have been detected in or have reasonable probability of entering the groundwater resources of the state.

(21) "Substance" means any solid, liquid, semisolid, dissolved solid or gaseous material, naturally occurring or man-made chemical, parameter for measurement of water quality or biological organism which, in its original form, or as a metabolite or a degradation or waste product, may decrease the quality of groundwater.

(22) "Wastewater and sludge storage or treatment lagoon" means a natural or man-made containment structure, constructed primarily of earthen materials for the treatment or storage of wastewater or sludge, which is not a land disposal system.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; cr. (1m), am. (7), (17) and (18), Register, October, 1988, No. 394, eff. 11-1-88.

Subchapter II — Groundwater Quality Standards

NR 140.10 Public health related groundwater standards. The groundwater quality standards for substances of public health concern are listed in Table 1.

Note: For all substances that have carcinogenic, mutagenic or teratogenic properties or interactive effects, the preventive action limit is 10% of the enforcement standard. The preventive action limit is 20% of the enforcement standard for all other substances that are of public health concern. Based on action by the natural resources board, which amended previous enforcement standards while not amending preventive action limits, the preventive action limits for benzene, 1,2-dichloroethane, 1,1-dichloroethylene, fluoride, trichloroethylene and vinyl chloride are less than the percentage of the enforcement standard specified by s. 160.15(1), Stats. Enforcement standards and preventive action limits for additional substances will be added to Table I as recommendations are developed pursuant to ss. 160.07, 160.13 and 160.15, Stats.

Table 1
Public Health Groundwater Quality Standards

Substance	*Enforcement Standard (micrograms per liter - except as noted)*	*Preventive Action Limit (micrograms per liter - except as noted)*
Alachlor	0.5	0.05
Aldicarb	10	2
Arsenic	50	5
Atrazine	3.5	0.35
Bacteria, Total Coliform	Less than one in 100 ml for membrane filter method or not present in any 10 ml portion by fermentation tube method for both preventive action limit and enforcement standard	
Barium	1 milligram/liter (mg/l)	.2 mg/l
Benzene	5	.067
Bromodichloromethane	179	36
Butylate	67	6.7
Cadmium	10	.1
Carbaryl	960	192
Carbofuran	50	10
Carbon Tetrachloride	5	.5
Chloramben	150	30
Chloroform	6	.6
Chromium	50	5
Cyanazine	12.5	1.25
Cyanide	200	40
Dibromochloromethane	215	43
1,2-Dibromoethane (EDB)	.010	.001
1,2-Dibromo-3-chloropropane (DBCP)	.05	.005
Dicamba	300	60
1,2-Dichlorobenzene	1250	125
1,3-Dichlorobenzene	1250	125
p-Dichlorobenzene (1,4-Dichlorobenzene)	75	15
1,1-Dichloroethane	850	85
1,2-Dichloroethane	5	.05
1,1-Dichloroethylene	7	.024
1,2-Dichloroethylene (cis)	100	10
1,2-Dichloroethylene (trans)	100	20
2,4-Dichlorophenoxyacetic Acid	100	20
Dimethoate	2	.4
Dinoseb	13	2.6
Dioxin (2, 3, 7, 8-TCDD)	.00000022	.000000022

Endrin	.2	.02
EPTC (Eptam)	250	50
Ethylbenzene	1360	272
Fluoride	4 mg/l	.44 mg/l
Fluorotrichloromethane (Freon-11)	3490	698
Lead	50	5
Lindane	.02	.002
Mercury	2	2
Methoxychlor	100	20
Methylene Chloride (Dichloromethane)	150	15
Metolachlor	15	1.5
Metribuzin	250	50
Nitrate + Nitrite (as N)	10 mg/l	2 mg/l
Pentachlorophenol	300	30
Selenium	10	1
Silver	50	10
Simazine	2.15 mg/l	.215 mg/l
Tetrachloroethylene	1	.1
Tetrahydrofuran	50	10
Toluene	343	68.6
Toxaphene	.0007	.00007
1,1,1-Trichloroethane	200	40
1,1,2-Trichloroethane	.6	.06
Trichloroethylene	5	.18
2,4,5-Trichlorophenoxypropionic Acid	10	2
Trifluralin	7.5	.75
Vinyl Chloride	.2	.0015
Xylene	620	124

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. table 1, Register, October, 1988, No. 394, eff. 11-1-88; am. table 1, Register, September, 1990, No. 417, eff. 10-1-90.

NR 140.12 Public welfare related groundwater standards. The groundwater quality standards for substances of public welfare concern are listed in Table 2.

Note: For each substance of public welfare concern, the preventive action limit is 50% of the established enforcement standard.

Table 2
Public Welfare Groundwater Quality Standards

Substance	*Enforcement Standard (milligrams per liter - except as noted)*	*Preventive Action Limit (milligrams per liter - except as noted)*
Chloride	250	125
Color	15 color units	7.5 color units
Copper	1.0	.5
Foaming agents MBAS (Methylene-Blue Active Substances)	.5	.25
Iron	.3	.15
Manganese	.05	.025
Odor	3 (Threshold Odor No.)	1.5 (Threshold Odor No.)
Sulfate	250	125
Zinc	5	2.5

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. table 2, Register, October, 1990, No. 418, eff. 11-1-90.

NR 140.14 Statistical procedures. (1) If a preventive action limit or an enforcement standard for a substance listed in Table 1 or 2, an alternative concentration limit issued in accordance with s. NR 140.28 or a preventive action limit for an indicator parameter established according to s. NR 140.20 (2) is attained or exceeded at a point of standards application:

(a) The owner or operator of the facility, practice or activity at which a standard is attained or exceeded shall notify the appropriate regulatory agency that a standard has been attained or exceeded; and

(b) The regulatory agency shall require a remedial response in accordance with the rules promulgated under s. 160.21, Stats. No remedial response shall be required if it is demonstrated to the satisfaction of the appropriate regulatory agency that a scientifically valid determination cannot be made that the preventive action limit or enforcement standard for a substance in Table 1 or 2 has been attained or exceeded based on consideration of sampling procedures or laboratory precision and accuracy, at a significance level of 0.05.

(2) The regulatory agency shall use one or more valid statistical procedures to determine if a change in the concentration of a substance has occurred. A significance level of 0.05 shall be used for all tests.

(3) In addition to sub. (2), the following applies when a preventive action limit or enforcement standard is below the limit of quantitation:

(a) If a substance is not detected in a sample and the limit of detection is higher than the preventive action limit or enforcement standard for that substance, the preventive action limit or enforcement standard shall be considered not to have been attained or exceeded.

(b) If a substance is reported to be present in a sample above the limit of detection but below the limit of quantitation, and if the preventive action limit or enforcement standard for that substance is below the limit of detection, the preventive action limit or enforcement standard shall be considered to have been attained or exceeded only if the presence of that substance has been confirmed by the use of an appropriate statistical test at a significance level of 0.05.

(c) The owner or operator of the facility, practice or activity shall report the limit of detection and the limit of quantitation with the sample results when requested by the regulatory agency.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1) (intro.) and (b), r. and recr. (2), Register, October, 1988, No. 394, eff. 11-1-88; am. (1) (b), (2) and (3) (b), Register, September, 1990, No. 417, eff. 10-1-90.

NR 140.16 Monitoring and laboratory data requirements. (1) All water quality samples collected to determine compliance with ch. 160, Stats., except samples collected for total coliform bacteria analysis and field analyses for pH, specific conductance, and temperature, shall be analyzed by a laboratory certified or registered under ch. NR 149. Samples for total coliform bacteria analysis shall be analyzed by the state laboratory of hygiene or at a laboratory approved or certified by the department of health and social services. The results of the analysis shall be submitted to the department and the appropriate regulatory agency. Except as provided in s. NR 205.07 (3) (c) for wastewater permittees, this subsection does not require the submission of groundwater monitoring data which is collected voluntarily and which is not being collected to determine compliance with this chapter. The samples shall be collected in accordance with procedures specified by the department or, where no procedures are specified, in accordance with published sampling procedures.

Note: Published sampling procedures include those contained in the following sources. Other published sampling procedures are also acceptable.

1. "Groundwater Sampling Procedures Guidelines." Wisconsin Department of Natural Resources, PUBL-WR-153, February 1987.

2. "Groundwater Sampling Procedures Field Manual." Wisconsin Department of Natural Resources, PUBL-WR-168, September 1987.

3. "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Sites." EPA SW-611, Office of Water and Waste Management, U.S. Environmental Protection Agency, Dec. 1980, Washington, D.C.

4. "Techniques of Water Resources Investigations of the United States Geological Survey, Guidelines for Collection and Field Analysis of Ground Water Samples for Selected Unstable Constituents," Book I, Chapter D2, U.S. Geological Survey, Washington, D.C.

5. "Procedures for the Collection of Representative Water Quality Data from Monitoring Wells," Cooperative Groundwater Report 7, Illinois State Water Survey, 1981, Champaign, Illinois.

6. "Manual of Ground Water Sampling Procedures," NWWA/EPA Series, Robert S. Kerr, Environmental Research Laboratory, 1981, Ada, Oklahoma.

(2) The laboratory shall utilize the analytical methodology specified in rules or approved by the regulatory agency. Where no analytical methodology is specified, the laboratory shall use an analytical methodology with a limit of detection and limit of quantitation below the preventive action limit. Where the limit of detection or limit of quantitation is above the preventive action limit for that substance, the laboratory shall use the best available analytical methodology to produce the lowest limit of detection and limit of quantitation.

(3) If the owner or operator of a facility, practice or activity believes that a sample result does not represent groundwater quality in the vicinity of the facility, practice or activity, the owner or operator shall resample the appropriate well or wells to obtain a representative sample at the earliest possible time. All sample results shall be submitted to the department and the appropriate regulatory agency with an explanation of why the owner or operator believes that all or some of the results are invalid.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1), Register, September, 1990, No. 417, eff. 10-1-90.

Subchapter III — Evaluation and Response Procedures

NR 140.20 Indicator parameter groundwater standards. (1) ESTABLISHING BACKGROUND WATER QUALITY. Background water quality at a facility, practice or activity at which monitoring is required shall be established by sampling one or more monitoring points at locations and depths sufficient to yield groundwater samples that are representative of background water quality at or near the facility, practice or activity. Background water quality shall be determined for indicator parameters specified by the department. Background water quality for indicator parameters shall be established by averaging a minimum of 8 sample results from each well. The department may exclude any sample result which is nonrepresentative of background water quality. In making the calculations required in this section, the department may use as many representative sample points as are available.

(2) ESTABLISHING PREVENTIVE ACTION LIMITS FOR INDICATOR PARAMETERS. For each indicator parameter for which groundwater monitoring is required by the department, the preventive action limit shall be established based upon a change of water quality with respect to background water quality according to the methodology specified in pars. (a) to (c) and in Table 3.

(a) For field pH, the preventive action limit shall be one pH unit above or below the pH of the background water quality.

(b) For field temperature, the preventive action limit shall be 3 standard deviations or 10°F (5.6°C), whichever is greater, above or below the temperature of the background water quality.

(c) For all other indicator parameters, the preventive action limit shall be the background water quality for that parameter plus 3 standard deviations or the background water quality plus the increase of that parameter listed in Table 3, whichever is greater.

Note: The standard deviation for a group of samples is equal to the square root of: the value of the sum of the squares 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.

Table 3
Methodology for Establishing Preventive Action Limit for Indicator Parameters

Parameter	*Minimum Increase (mg/l)*	
Alkalinity	100	
Biochemical oxygen demand (BOD_5)	25	
Boron	2	
Calcium	25	
Chemical oxygen demand (COD)	25	
Magnesium	25	
Nitrogen series		
—Ammonia nitrogen	2	
—Organic nitrogen	2	
—Total nitrogen	5	
Potassium	5	
Sodium	10	
Field specific conductance	200	micromhos/cm
Total dissolved solids (TDS)	200	
Total hardness	100	
Total organic carbon (TOC)	1	
Total organic halogen (TOX)	.25	

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. table 3, Register, October, 1990, No. 418, eff. 11-1-90.

NR 140.22 Point of standards application. (1) Facilities, practices or activities regulated by the department shall be designed to minimize the level of substances in groundwater and to comply with the preventive action limits to the extent technically and economically feasible at the following locations:

(a) Any point of present groundwater use;

(b) Any point beyond the boundary of the property on which the facility, practice or activity is located; and

(c) Any point within the property boundaries beyond the 3-dimensional design management zone if one is established by the deparment at each facility, practice or activity under sub. (5).

(2) The point of standards application to determine if a preventive action limit has been attained or exceeded is any point at which groundwater is monitored.

(3) The point of standards application to determine whether an enforcement standard has been attained or exceeded shall be the following locations:

(a) Any point of present groundwater use;

(b) Any point beyond the boundary of the property on which the facility, practice or activity is located;

(c) Any point within the property boundaries beyond the 3 dimensional design management zone if one is established by the department at each facility, practice or activity under sub. (5).

Note: The boundary beyond which the enforcement standards apply is the closer of the property boundary or the design management zone boundary to the waste boundary for the facility, practice or activity.

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(4) For spills and discharges regulated under s. 144.76, Stats., or s. NR 181.08, the point of standards application shall be every point at which goundwater is monitored to determine if a preventive action limit or enforcement standard has been attained or exceeded.

(5) (a) The design management zone for facilities, practices or activities subject to regulation by the department shall be an area enclosed by vertical boundaries which extend from the land surface downward through all saturated geological formations. The design management zone shall extend horizontally beyond the waste boundary to the distance indicated in Table 4 for the specific type of facility, practice or activity. The waste boundary shall be the outermost limit at which waste from a facility, practice or activity has been stored, applied or disposed of, or permitted or approved for storage, application or disposal. For hazardous waste facilities regulated under ss. 144.60 to 144.74, Stats., the waste boundary shall include the horizontal space taken up by any liner, dike or other barrier to contain waste.

(b) In issuing or reissuing a permit, license or approval, the department may consider an expansion or reduction of the design management zone at a regulated or proposed facility, practice or activity by a horizontal distance not to exceed 50% of the distance listed in Table 4.

(c) The department shall consider the following factors in determining whether to expand or reduce the design management zone:

1. Nature, thickness and permeability of unconsolidated materials, including topography;

2. Nature and permeability of bedrock;

3. Groundwater depth, flow direction and velocity;

4. Waste volume, waste type and characteristics, including waste loading;

5. Contaminant mobility;

6. Distances to property boundary and surface waters;

7. Engineeering design of the facility, practice or activity;

8. Life span of the facility, practice or activity;

9. Present and anticipated uses of land and groundwater; and

10. Potential abatement options if an enforcement standard is exceeded.

(d) The design management zone may not be expanded or reduced unless it has been demonstrated to the satisfaction of the department that the preventive action limits and enforcement standards will be met at the adjusted design management zone. The design management zone may not be expanded unless it has been demonstrated to the satisfaction of the department that the preventive action limits and enforcement standards cannot be met at the design management zone specified in Table 4.

Table 4

Type of Facility, Practice or Activity	*Horizontal Distances for the Design Management Zone*
Land disposal systems regulated under ch. 144 or 147, Stats.	250 feet
Wastewater and sludge storage or treatment lagoons regulated under ch. 144 or 147, Stats.	100 feet
Solid waste disposal facilities regulated under ss. 144.43 to 144.47, Stats., which have feasibility reports approved after October 1, 1985.	150 feet
All other solid waste disposal facilities regulated under ss. 144.43 to 144.47, Stats.	300 feet
Hazardous waste disposal facilities, waste piles, landfills and surface impoundments subject to regulation under s. NR 181.49 (5).	300 feet
Hazardous waste disposal facilities, waste piles, landfills and surface impoundments subject to regulation under s. NR 181.49 (6).	0 feet

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1) (b), Register, October, 1988, No. 394, eff. 11-1-88.

NR 140.24 Responses when a preventive action limit is attained or exceeded. (1) If the concentration of a substance, including indicator parameters in groundwater attains or exceeds a preventive action limit at a point of standards application:

(a) The owner or operator of the facility, practice or activity shall notify the department in writing when monitoring data is submitted that a preventive action limit has been attained or exceeded in accordance with any deadlines in applicable statutes, rules, permits or plan approvals. Where no deadlines are imposed, the owner or operator shall notify the department as soon as practical after the results are received. The notification shall provide a preliminary analysis of the cause and significance of the concentration.

(b) Upon receipt of the notice under par. (a), the department shall evaluate the information and, if further information is required to make the assessment under par. (c), may direct the owner or operator to prepare and submit a report by a specified deadline. The report shall assess the cause and significance of the increased concentration based on a consideration of the factors identified in par. (c) and shall propose a response to meet the objectives of sub. (2).

(c) The department shall assess the cause and significance of the concentration of the substance in determining the appropriate response measures to meet the objectives of sub. (2). If a preventive action limit is attained or exceeded at a monitoring point within the design management zone, the department shall evaluate the location of the monitoring point, specific characteristics of the site, the nature of the substance involved and the likelihood of substance migration in assessing the need for response activities under sub. (2). In addition to all other relevant information, the department shall consider the information submitted under sub. (1) and the following factors where applicable:

1. Background water quality. a. The department shall compare background water quality data and monitoring data from wells downgradient of the facility, practice or activity to determine if downgradient water quality is adversely affected. If the background water quality at a facil-

ity, practice or activity is not known or is inadequately defined, the department may require additional sampling of existing wells, or installation and sampling of additional wells, or both.

b. Except for substances which are carcinogenic, teratogenic or mutagenic in humans, before requiring a response at a site where the background concentration of a substance is determined to be equal to or greater than the preventive action limit, the department shall determine that the proposed remedial action will protect or substantially improve groundwater quality notwithstanding the background concentrations of naturally occurring substances.

2. Reliability of sampling data. As part of its review of the quality of the sampling data, the department shall evaluate the sampling procedures, precision and accuracy of the analytical test, size of the data set, and the quality control and quality assurance procedures used. If there is insufficient information to evaluate the reliability of the sampling data, the department may require additional samples or other changes in the monitoring program at the facility, practice or activity.

3. Public health, welfare and environmental effects of the substance. The department shall consider the public health, welfare and environmental effects of the substance, including but not limited to its mobility in the subsurface, environmental fate, the risks considered when the standard was adopted and whether it is carcinogenic, mutagenic, teratogenic or has interactive effects with other substances.

4. Probability that a preventive action limit or an enforcement standard may be attained or exceeded outside the design management zone. In evaluating the probability that a preventive action limit or an enforcement standard may be attained or exceeded outside the design management zone, the department shall consider, at a minimum, geologic conditions, groundwater flow rate and direction, contaminant mobility in the subsurface and environmental fate.

5. Performance of the facility, practice or activity. The department shall consider whether the facility, practice or activity is performing as designed. The department shall consider the type, age and size of the facility, practice or activity; the type of design, if applicable; the operational history; and other factors related to performance of the facility, practice or activity as appropriate.

6. Location of the monitoring point. The department shall consider the location of the monitoring point in relation to the facility, practice or activity and the design management zone in assessing the appropriate response.

7. Other known or suspected sources of the substance in the area. If other known or suspected sources are present in the vicinity of a facility, practice or activity of concern, the department shall evaluate the probability of contributions from other sources of the substance. The department shall consider, at a minimum, the number, size, type and age of nearby sources; the groundwater flow patterns; and the substances involved.

8. Hydrogeologic conditions. The department shall consider the geologic and groundwater conditions, including but not limited to the nature, thickness and permeability of the unconsolidated materials; the nature and permeability of bedrock; the depth to the water table;

groundwater flow gradients, both vertical and horizontal; the position of the facility, practice or activity within the groundwater flow system; and the present and potential groundwater use in the vicinity of the facility, practice or activity at which an exceedance occurs. If there is insufficient hydrogeologic information, the department may require additional information.

9. Extent of groundwater contamination. The department shall consider the current and anticipated future extent of groundwater contamination in 3 dimensions. If water supplies are affected or threatened, the department shall evaluate the existing effects and potential risks of the substance on the potable water supplies. If the extent of contamination is not known, the department may require further documentation of the extent of contamination.

10. Alternate responses. The department shall evaluate alternate responses, including consideration of the technical and economic feasibility of alternate methods of disposal, the practicality of stopping the further release of the substance and the risks and benefits of continued operation of the facility, practice or activity.

(2) Based on the evaluation of the report required under sub. (1) and the factors in sub. (1) (c), the department shall specify the responses to be implemented by the owner or operator of the facility, practice or activity designed to:

(a) Minimize the concentration of the substance in groundwater at the point of standards application where technically and economically feasible;

(b) Regain and maintain compliance with the preventive action limit. If the department determines that compliance with the preventive action limit is either not technically or economically feasible, the owner or operator shall achieve compliance with the lowest possible concentration which is technically and economically feasible; and

(c) Ensure that the enforcement standard is not attained or exceeded at the point of standards application.

(3) Except as otherwise provided in this subsection, the range of responses which the department may take or may require if a preventive action limit for an indicator parameter identified in Table 3 has been attained or exceeded, are one or more of the actions in items 1 to 4 in Table 5. The range of responses is one or more of the actions in items 1 to 6 of Table 5 in the event the department determines that:

(a) There is a threat to public health or welfare as a result of a preventive action limit for an indicator parameter being attained or exceeded; or

(b) The results demonstrate a significant design flaw or failure of the facility to contain substances, such that the facility can be expected to emit one or more of the substances on Table 1 or 2 in excess of a preventive action limit at a point of standards application.

(4) The range of responses which the department may take or may require if a preventive action limit for a substance of health or welfare concern has been attained or exceeded are listed in Table 5. More than one response may be required by the department.

Table 5

Range of Responses for Exceedance of a Preventive Action Limit for Indicator Parameters and Substances of Health or Welfare Concern

1. No action pursuant to s. NR 140.24 (5) and consistent with s. 160.23, Stats.
2. Sample wells or require sampling of wells.
3. Require a change in the monitoring program, including increased monitoring.
4. Require an investigation of the extent of groundwater contamination.
5. Require a revision of the operational procedures at the facility, practice or activity.
6. Require a change in the design or construction of the facility, practice or activity.
7. Require an alternate method of waste treatment or disposal.
8. Require prohibition or closure and abandonment of a facility, practice or activity in accordance with sub. (6).
9. Require remedial action to renovate or restore groundwater quality.
10. Revise rules or criteria on facility design, location or management practices.

(5) The department may determine that no response is necessary when:

(a) The concentration of a substance within a design management zone is detected above the preventive action limit, the enforcement standard has not been attained or exceeded within the design management zone, and the department determines that there is no indication that the preventive action limit will be attained or exceeded at any point outside the design management zone, or

(b) The background concentration of a substance is greater than the preventive action limit, the anticipated or detected incremental increase in the concentration of a substance which results from a specific facility, practice or activity is not greater than the preventive action limit, and the anticipated or detected concentration is not greater than the enforcement standard either within or outside of the design management zone.

(6) The department may not impose a prohibition on a practice or activity or require closure of a facility which produces the substance unless the department:

(a) Bases its decision upon reliable test data;

(b) Determines, to a reasonable certainty, by the greater weight of the credible evidence, that no other remedial action would prevent the violation of the enforcement standard at the point of standards application;

(c) Establishes the basis for the boundary and duration of the prohibition; and

(d) Ensures that any prohibition imposed shall be reasonably related in time and scope to maintaining compliance with the enforcement standard at the point of standards application.

(7) The department may take any actions within the context of regulatory programs established in statutes or rules outside of this chapter, if those actions are necessary to protect public health and welfare or prevent a significant damaging effect on groundwater or surface water quality for present or future consumptive or nonconsumptive uses, whether or not an enforcement standard and preventive action limit for a sub-

stance have been adopted under this chapter. Nothing in this chapter authorizes an impact on groundwater quality which would cause surface water quality standards contained in chs. NR 102 to 104 to be attained or exceeded.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (5) (intro.) and (6) (intro.), Register, October, 1988, No. 394, eff. 11-1-88.

NR 140.26 Responses when an enforcement standard is attained or exceeded. (1) If the concentration of a substance in groundwater attains or exceeds an enforcement standard at a point of standards application:

(a) The owner or operator of the facility, practice or activity shall notify the department in writing when monitoring data is submitted that an enforcement standard has been attained or exceeded in accordance with applicable statutes, rules, permit or plan approval. Where no deadlines are imposed, the owner or operator shall notify the department as soon as practical after the results are received. The notification shall provide a preliminary analysis of the cause and significance of the concentration.

(b) Upon receipt of the notice under par. (a), the department shall evaluate the information and, if further information is required to make the assessment under par. (c), may direct the owner or operator to prepare and submit a report by a specified deadline. The report shall assess the cause and significance of the increased concentration based on a consideration of the factors identified in s. NR 140.24 (1) (c) and shall propose a response to achieve compliance with the enforcement standard at the point of standards application and to comply with sub. (5).

(c) The department shall assess the cause and significance of the concentration of the substance in determining the appropriate response measures to achieve compliance with the enforcement standard at the point of standards application and to comply with sub. (5). In addition to all other relevant information, the department shall consider the information submitted under sub. (1) and the factors listed in s. NR 140.24 (1) (c), where applicable.

(2) Based on the evaluation of the increased concentration as outlined in sub. (1), the department shall require responses as necessary to achieve compliance with the enforcement standard at the point of standards application and to comply with sub. (5). The range of responses which the department may take or require if an enforcement standard for a substance of public health or welfare concern has been attained or exceeded at a point of standards application are listed in Table 6. More than one response may be required by the department. In addition, the department may require one or more responses from Table 5, except number one.

Table 6

Range of Responses for Exceedance of Enforcement Standards for Substances of Health or Welfare Concern

1. Require a revision of the operational procedures at a facility, practice or activity.
2. Require a change in the design or construction of the facility, practice or activity.
3. Require an alternate method of waste treatment or disposal.
4. Require prohibition or closure and abandonment of a facility, practice or activity.
5. Require remedial action to renovate or restore groundwater quality.
6. Revise rules or criteria on facility design, location or management practices.

(3) If an activity or practice is not subject to regulation under subch. IV of ch. 144 or 147, Stats., and if the concentration of a substance in groundwater attains or exceeds an enforcement standard at a point of standards application, the department shall take the following responses unless it can be shown to the department that, to a reasonable certainty, by the greater weight of the credible evidence, an alternative response will achieve compliance with the enforcement standard at the point of standards application:

(a) Prohibit the activity or practice which uses or produces the substance; and

(b) Require remedial actions with respect to the specific site in accordance with this chapter.

(4) If nitrates or any substance of welfare concern only attains or exceeds an enforcement standard, the department is not required to impose a prohibition or close a facility if it determines that:

(a) The enforcement standard was attained or exceeded, in whole or in part, because of high background concentrations of the substance; and

(b) The additional concentration does not represent a public welfare concern.

(5) When compliance with the enforcement standard is achieved at the point of standards application, s. NR 140.24 applies.

(6) The department may take any actions within the context of regulatory programs established in statutes or rules outside of this chapter, if those actions are necessary to protect public health and welfare or prevent a significant damaging effect on groundwater or surface water quality for present or future consumptive or nonconsumptive uses, whether or not an enforcement standard and preventive action limit for a substance have been adopted under this chapter. Nothing in this chapter authorizes an impact on groundwater quality which would cause surface water quality standards contained in chs. NR 102 to 104 to be attained or exceeded.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85.

NR 140.27 Responses when an enforcement standard is attained or exceeded at a location other than a point of standards application. If the concentration of a substance in groundwater attains or exceeds an enforcement standard at a location other than a point of standards application for an enforcement standard, s. NR 140.24 shall apply.

History: Cr. Register, October, 1988, No. 394, eff. 11-1-88.

NR 140.28 Exemptions. (1) EXEMPTIONS REQUIRED. (a) The department may not approve a proposed facility, practice or activity at a location where a preventive action limit or enforcement standard adopted under s. NR 140.10 or 140.12 has been attained or exceeded unless an exemption has been granted under this section.

(b) Remedial action is required under s. NR 140.24 or 140.26 when a preventive action limit or an enforcement standard has been attained or exceeded at a point of standards application unless an exemption has been granted under this section.

(2) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS BELOW THE PREVENTIVE ACTION LIMIT. The department may grant an exemption under this section when a preventive action limit is attained or exceeded if it determines that:

(a) The measured or anticipated increase in the concentration of the substance will be minimized to the extent technically and economically feasible;

(b) Compliance with the preventive action limit is either not technically or economically feasible;

(c) The enforcement standard for that substance will not be attained or exceeded at the point of standards application; and

(d) Any existing or projected increase in the concentration of the substance above the background concentration does not present a threat to public health or welfare.

(3) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS ABOVE A PREVENTIVE ACTION LIMIT. (a) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of nitrate or a substance of public welfare concern attains or exceeds the preventive action limit if the facility, practice or activity is designed to achieve the lowest possible concentration for that substance which is technically and economically feasible and the existing or anticipated increase in the concentration of the substance does not present a threat to public health or welfare.

(b) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of a substance of public health concern, other than nitrate, attains or exceeds a preventive action limit for that substance:

1. If the facility, practice or activity has not caused and will not cause the further release of that substance into the environment; or

2. If the background concentration of the substance does not exceed the enforcement standard for that substance, the facility, practice or activity has not caused and will not cause the concentration of the substance to exceed the enforcement standard for that substance at a point of standards application and the facility, practice or activity is designed to achieve the lowest possible concentration of that substance which is technically and economically feasible.

(4) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS ABOVE AN ENFORCEMENT STANDARD. (a) The depart-

ment may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of nitrate or a substance of public welfare concern attains or exceeds an enforcement standard if the facility, practice or activity is designed to achieve the lowest possible concentration for that substance which is technically and economically feasible and the existing or anticipated increase in the concentration of the substance does not present a threat to public health or welfare.

(b) 1. The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of a substance of public health concern, other than nitrate, attains or exceeds the enforcement standard for that substance if:

a. The facility has not caused and will not cause the further release of that substance into the environment; or

b. 1) The facility is designed to achieve the lowest possible concentration of that substance which is technically and economically feasible; and

2) The existing or anticipated increase in the concentration of the substance has not caused or will not cause an increased threat to public health or welfare; and

3) The existing or anticipated incremental increase in the concentration of the substance by itself, has not exceeded or will not exceed the preventive action limit.

2. The department shall take action under s. NR 140.26 if it determines that the increase in the concentration of the substance causes an increased threat to public health or welfare or it determines that the incremental increase in the concentration of the substance, by itself, exceeds the preventive action limit.

(5) EXEMPTION PROCEDURES. If the department grants an exemption for a substance it shall specify:

(a) The substance to which the exemption applies;

(b) The terms and conditions of the exemption, which may include an alternative concentration limit, under which the department may seek remedial action under s. NR 140.24 or 140.26 relating to the substance; and

(c) Any other conditions relating to the exemption.

History: Cr. Register, September, 1985, No. 357, eff. 10-1-85; am. (1) (a) and (b), (3) (a), (b) (intro.) and 2., (4) (a) and (b) 1. and (5) (b), Register, October, 1988, No. 394, eff. 11-1-88.

APPENDIX B
WATER QUALITY STANDARDS AND HEALTH ADVISORIES

Water Quality Standards and Health Advisories

Revised 5-21-91

Chemical	MCL (a)		MCLG (b)		Secondary MCL (c)		OFFICE OF DRINKING WATER HEALTH ADVISORIES (d)					
	Proposed ug/l	Final ug/l	Proposed ug/l	Final ug/l	Proposed ug/l	Final ug/l	1 Day Health Advisory (e) Child ug/l	10 Day Health Advisory (f) Child ug/l	Longer Term Health Advisory (g) Child ug/l	Longer Term Health Advisory (g) Adult ug/l	DWEL (h) ug/l	Lifetime HA (i) ug/l
Acrylamide	-	TT	-	0	-	-	1500	300	20	70	7	-
Adipates [Di(ethylhexyl)adipate]	500	-	500	-	-	-	-	-	-	-	20000	500
Alachlor	-	2	-	0	-	-	100	100	-	-	400	-
Aldicarb (m)	3	-	1	-	-	-	-	-	-	-	-	-
Aldicarb sulfone (m)	3	-	2	-	-	-	-	-	-	-	100	2
Aldicarb sulfoxide (m)	3	-	1	-	-	-	-	-	-	-	4	1
Aluminum	-	-	-	-	-	50-200	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-	30000
Antimony	10/5	-	3	-	-	-	-	-	-	-	-	-
Arsenic	-	50 k	-	k	-	-	-	-	-	-	-	-
Asbestos (Million fibers/L)	-	7000000	-	7000000	-	-	-	-	-	-	-	-
Atrazine	-	3	-	3	-	-	100	100	50	200	200	3
Barium	2000	-	2000	-	-	-	-	-	-	-	2000	
Baygon	-	-	-	-	-	-	40	40	40	100	100	3
Bentazon	-	-	-	-	-	-	300	300	300	900	90	20
Benzene	-	5	-	0	-	-	200	200	-	-	-	-
Benzo[a]anthracene	0.1	-	0	-	-	-	-	-	-	-	-	-
Benzo[g,h,i]perylene	0.2	-	0.2	-	-	-	-	-	-	-	-	-
Benzo[b]fluoranthene	0.2	-	0	-	-	-	-	-	-	-	-	-
Benzo[k]fluoranthene	0.2	-	0	-	-	-	-	-	-	-	-	-
Benzo[a]pyrene	0.2	-	0	-	-	-	-	-	-	-	-	-
Beryllium	1	-	0	-	-	-	-	-	-	-	-	-
gamma BHC (Lindane)	-	0.2	-	0.2	-	-	1000	1000	30	100	10	0.2
bis(2-Chloroisopropyl)ether	-	-	-	-	-	-	4000	4000	4000	13000	1000	300
bis(2-Ethylhexyl)phthalate	4	-	0	-	-	-	-	-	-	-	700	-
Boron	-	-	-	-	-	-	-	-	-	-	-	-
Bromacil	-	-	-	-	-	-	5000	5000	3000	9000	5000	90
Bromochloromethane	-	-	-	-	-	-	50000	1000	1000	5000	500	90
Bromodichloromethane	-	100 L	-	-	-	-	-	-	-	-	-	-
Bromoform	-	100 L	-	-	-	-	-	-	-	-	-	-
Bromomethane	-	-	-	-	-	-	100	100	100	500	50	10
2-Butanone (MEK)	-	-	-	-	-	-	80000	8000	3000	9000	900	200
Butylate	-	-	-	-	-	-	2000	2000	1000	4000	2000	350
Butylbenzyl phthalate	100	-	100	-	-	-	-	-	-	-	6000	-
Cadmium	-	5	-	5	-	-	40	40	5	20	20	5
Carbaryl	-	-	-	-	-	-	1000	1000	1000	1000	4000	700

Water Quality Standards and Health Advisories

Revised 5-21-91

Chemical	MCL (a)		MCLG (b)		Secondary MCL (c)		OFFICE OF DRINKING WATER HEALTH ADVISORIES (d)					
							1 Day Health Advisory (e)	10 Day Health Advisory (f)	Longer Term Health Advisory (g)		DWEL	Lifetime HA
	Proposed	Final	Proposed	Final	Proposed	Final	Child	Child	Child	Adult	(h)	(i)
	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Carbofuran	-	40	-	40	-	-	50	50	50	200	200	40
Carbon tetrachloride	-	5	-	0	-	-	4000	200	70	300	30	-
Carboxin	-	-	-	-	-	-	1000	1000	1000	4000	4000	700
Chloramben	-	-	-	-	-	-	3000	3000	200	500	500	100
Chlordane	-	2	-	0	-	-	60	60	-	-	2	-
Chloride	-	-	-	-	-	250000	-	-	-	-	-	-
Chlorobenzene	-	100	-	100	-	-	2000	2000	2000	7000	700	100
Chlorodibromomethane	-	100	-	-	-	-	-	-	-	-	-	-
Chloroform	-	100	-	-	-	-	-	-	-	-	-	-
Chlorothalonil	-	-	-	-	-	-	200	200	200	500	500	-
Chlorotoluene (o-, p-)	-	-	-	-	-	-	2000	2000	2000	7000	700	100
Chromium (total)	-	100	-	100	-	-	1000	1000	200	800	200	100
Chyrsene	0.2	-	0	-	-	-	-	-	-	-	-	-
Cyanazine	-	-	-	-	-	-	100	100	20	70	70 k	10 k
Color	-	-	-	-	-	15 units	-	-	-	-	-	-
Copper	1300	-	1300	-	-	1000	-	-	-	-	-	-
Cyanide	200	-	200	-	-	-	200	200	200	800	800	200
2,4-D	-	70	-	70	-	-	1000	300	100	400	400	70
DCPA (Dacthal)	-	-	-	-	-	-	80000	80000	5000	20000	20000	4000
Dalapon	200	-	200	-	-	-	3000	3000	300	900	900	200
Diazinon	-	-	-	-	-	-	20	20	5	20	3	0.6
Dibenz[a,h]anthracene	0.2	-	0	-	-	-	-	-	-	-	-	-
Dibromochloropropane (DBCP)	-	0.2	-	0	-	-	200	50	-	-	-	-
Dicamba	-	-	-	-	-	-	300	300	300	1000	1000	200
Dichloroacetic acid	-	-	-	-	-	-	50000	50000	500	2000	200	3
1,2-Dichlorobenzene (o-)	-	600	-	600	10	-	9000	9000	9000	30000	3000	600
1,3-Dichlorobenzene (m-)	-	600	-	600	-	-	9000	9000	9000	30000	3000	600
1,4-Dichlorobenzene (p-)	-	75	-	75	5	-	10000	10000	10000	40000	4000	75
Dichlorodifluoromethane	-	-	-	-	-	-	40000	40000	9000	30000	5000	1000
1,2-Dichloroethane	-	5	-	0	-	-	700	700	700	2600	-	-
1,1-Dichloroethene	-	7	-	7	-	-	2000	1000	1000	4000	400	7
trans-1,2-Dichloroethene	-	100	-	100	-	-	20000	2000	2000	6000	600	100
cis-1,2-Dichloroethene	-	70	-	70	-	-	4000	3000	3000	11000	400	70
1,2-Dichloropropane	-	5	-	0	-	-	-	90	-	-	-	-
1,3-Dichloropropene	-	-	-	-	-	-	30	30	30	100	10	-
Dieldrin	-	-	-	-	-	-	0.5	0.5	0.5	2	2	-

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Chemical	MCL (a)		MCLG (b)		Secondary MCL (c)		OFFICE OF DRINKING WATER HEALTH ADVISORIES (d)					
	Proposed ug/l	Final ug/l	Proposed ug/l	Final ug/l	Proposed ug/l	Final ug/l	1 Day Health Advisory (e) Child ug/l	10 Day Health Advisory (f) Child ug/l	Longer Term Health Advisory (g) Child ug/l	Longer Term Health Advisory (g) Adult ug/l	DWEL (h) ug/l	Lifetime HA (i) ug/l
Diisopropyl methylphosphonate	-	-	-	-	-	-	8000	8000	8000	30000	3000	600
Dimethrin	-	-	-	-	-	-	10000	10000	10000	40000	10000	2000
1;3-Dinitrobenzene	-	-	-	-	-	-	40	40	40	140	5	1
Dinoseb	7	-	7	-	-	-	300	300	10	40	40	7
p-Dioxane	-	-	-	-	-	-	4000	400	-	-	-	-
Diphenamid	-	-	-	-	-	-	300	300	300	1000	1000	200
Diquat	20	-	20	-	-	-	-	-	-	-	80	20
Disulfoton	-	-	-	-	-	-	10	10	3	9	1	0.3
Diuron	-	-	-	-	-	-	1000	1000	300	900	70	10
Endothall	100	-	100	-	-	-	800	800	200	200	700	100
Endrin	2	-	2	-	-	-	20	20	3	10	10	2
Epichlorohydrin	-	TT	-	0	-	-	100	100	70	70	70	-
Ethylbenzene	-	700	-	700	30	-	30000	3000	1000	3000	3000	700
Ethylene dibromide (EDB)	-	0.05	-	0	-	-	8	8	-	-	-	-
Ethylene glycol	-	-	-	-	-	-	20000	6000	6000	20000	40000	7000
ETU	-	-	-	-	-	-	300	300	100	400	3	-
Fenamiphos	-	-	-	-	-	-	9	9	5	20	9	2
Fluometuron	-	-	-	-	-	-	2000	2000	2000	5000	400	90
Fluorene	0.2	-	0	-	-	-	-	-	-	-	-	-
Fluoride	-	4000 k	-	4000 k	-	2000	-	-	-	-	-	-
Fluorotrichloromethane	-	-	-	-	-	-	7000	7000	3000	10000	10000	2000
Foaming agents	-	-	-	-	-	500	-	-	-	-	-	-
Fonofos	-	-	-	-	-	-	20	20	20	70	70	10
Glyphosate	700	-	700	-	-	-	20000	20000	1000	1000	4000	700
Heptachlor	-	0.4	-	0	-	-	10	10	5	5	20	-
Heptachlor epoxide	-	0.2	-	0	-	-	10	-	0.1	0.1	0.4	-
Hexachlorobenzene	1	-	0	-	-	-	50	50	50	200	30	-
Hexachlorobutadiene	-	-	-	-	-	-	300	300	100	400	70	1
Hexachlorocyclopentadiene	50	-	50	-	8	-	-	-	-	-	200	-
Hexachloroethane	-	-	-	-	-	-	5000	5000	100	500	40	1
n-Hexane	-	-	-	-	-	-	10000	4000	4000	10000	-	-
Hexazinone	-	-	-	-	-	-	3000	3000	3000	9000	1000	200
HMX	-	-	-	-	-	-	5000	5000	5000	20000	2000	400
Ideno(1,2,3-cd)pyrene	0.2	-	0	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	300	-	-	-	-	-	-
Lead (at source)	5 k	-	0	-	-	-	-	-	-	-	-	-

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Chemical	MCL (a)		MCLG (b)		Secondary MCL (c)		OFFICE OF DRINKING WATER HEALTH ADVISORIES (d)					
							1 Day Health Advisory (e)	10 Day Health Advisory (f)	Longer Term Health Advisory (g)		DWEL (h)	Lifetime HA (i)
	Proposed ug/l	Final ug/l	Proposed ug/l	Final ug/l	Proposed ug/l	Final ug/l	Child ug/l	Child ug/l	Child ug/l	Adult ug/l	ug/l	ug/l
Lead (at tap)	TT k	–	0	–	–	–	–	–	–	–	–	–
Maleic hydrazide	–	–	–	–	–	–	10000	10000	5000	20000	20000	4000
MCPA	–	–	–	–	–	–	100	100	100	400	50	10
Manganese	–	–	–	–	–	50	–	–	–	–	–	–
Mercury (inorganic)	–	2	–	2	–	–	–	–	–	2	10	2
Methomyl	–	–	–	–	–	–	300	300	300	300	900	200
Methoxychlor	–	40	–	40	–	–	6000	2000	50	2000	200	40
Methylene chloride	5	–	0	–	–	–	10000	2000	–	–	2000	–
Methyl parathion	–	–	–	–	–	–	300	300	30	100	9	2
Metolachlor	–	–	–	–	–	–	2000	2000	2000	5000	5000	100
Metribuzin	–	–	–	–	–	–	5000	5000	300	900	900	200
Naphthalene	–	–	–	–	–	–	500	500	400	1000	100	20
Nickel	100	–	100	–	–	–	1000	1000	100	600	600	100
Nitrate (as N)	–	10000	–	10000	–	–	–	10000 k	–	–	–	–
Nitrite (as N)	–	1000	–	1000	–	–	–	1000 k	–	–	–	–
Nitrate + Nitrate (as N)	–	10000	–	10000	–	–	–	–	–	–	–	–
Nitroquanidine	–	–	–	–	–	–	10000	10000	10000	40000	4000	700
Odor	–	–	–	–	–	3 threshold odor nos.	–	–	–	–	–	–
Oxamyl (Vydate)	200	–	200	–	–	–	200	200	200	900	900	200
PCBs	–	0.5	–	0	–	–	–	–	–	–	–	–
Paraquat	–	–	–	–	–	–	100	100	50	200	200	30
Pentachlorophenol	1	–	0	–	30	–	1000	300	300	1000	1000	–
pH	–	–	–	–	–	6.5–8.5	–	–	–	–	–	–
Picloram	500	–	500	–	–	–	20000	20000	700	2000	2000	500
Prometon	–	–	–	–	–	–	200	200	200	500	500	100
Pronamide	–	–	–	–	–	–	800	800	800	3000	3000	50
Propachlor	–	–	–	–	–	–	500	500	100	500	500	90
Propazine	–	–	–	–	–	–	1000	1000	500	2000	700	10
Propham	–	–	–	–	–	–	5000	5000	5000	20000	600	100
RDX	–	–	–	–	–	–	100	100	100	400	100	2
Selenium	–	50	–	50	–	–	–	–	–	–	–	–
Silver	–	L	–	–	–	100	–	–	–	–	–	–
Simazine	1	–	1	–	–	–	500	500	50	200	60	1
Styrene	–	100	–	100	–	10	20000	2000	2000	7000	7000	100

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Sulfate	400000/ 500000	-	400000/ 500000	-	-	250000	-	-	-	-	-	-
2,3,7,8-TCDD (Dioxin)	5x10-11	-	0	-	-	-	0.001	0.0001	0.00001	0.00004	0.00004	-
TDS	-	-	-	-	-	500000	-	-	-	-	-	-
Tebuthiuron	-	-	-	-	-	-	3000	3000	700	2000	2000	500
Terbacil	-	-	-	-	-	-	300	300	300	900	400	90
Terbufos	-	-	-	-	-	-	5	5	1	5	5	0.9
1,1,1,2-Tetrachloroethane	-	-	-	-	-	-	2000	2000	900	3000	1000	70
Tetrachloroethene	-	5	-	0	-	-	2000	2000	1000	5000	500	-
Thallium	2/1	-	0.5	-	-	-	-	-	-	-	-	-
Toluene	-	1000	-	1000	-	-	20000	2000	2000	7000	7000	1000
Toxaphene	5	-	0	-	-	-	500	40	-	-	3.5	-
2,4,5-T	-	-	-	-	-	-	800	800	800	1000	350	70
2,4,5-TP (Silvex)	-	50	-	50	-	-	200	200	70	300	300	50
1,2,4-Trichlorobenzene	9	-	9	-	-	-	100	100	100	500	50	9
1,3,5-Trichlorobenzene	-	-	-	-	-	-	600	600	600	2000	200	40
1,1,1-Trichloroethane	-	200	-	200	-	-	100000	40000	40000	100000	1000	200
1,1,2-Trichloroethane	5	-	3	-	-	-	600	400	400	1000	100	3
Trichloroethene	-	5	-	0	-	-	-	-	-	-	300	-
1,2,3-Trichloropropane	-	-	-	-	-	-	600	600	600	2000	200	40
Trifluralin	-	-	-	-	-	-	80	80	80	300	300	5
Trinitroglycerol	-	-	-	-	-	-	5	5	5	5	-	5
Trinitrotoluene	-	-	-	-	-	-	20	20	20	20	20	2
Vinyl chloride	-	2	-	0	-	-	3000	3000	10	50	-	-
Xylenes	-	10000	-	10000	-	-	40000	40000	40000	100000	60000	10000
Zinc	-	-	-	-	-	5000	-	-	-	-	-	0

a. Maximum Contaminant Levels (MCLs) are enforceable drinking water standards, developed under the Safe Drinking Water Act, that are set as close to MCLGs as feasible (with the use of the best technology, treatment techniques taking into consideration cost). MCLs are part of National Primary Drinking Water Regulations. MCLs are listed at 40 CFR.61 for organic contaminants and 40 CFR 141.62 for inorganic contaminants.

b. Maximum Contaminant Level Goal (MCLGs) are non-enforceable health goals, developed under the Safe Drinking Water for drinking water. They are set at levels at which no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety. MCLGs were previously named RMCLs. MCLGs are listed at 40 CFR 141.50 for organic chemicals and 40 CFR 141.51 for inorganic chemicals.

c. Secondary Maximum Contaminant Levels (SMCLs) are part of the National Secondary Drinking Water Regulations developed under the Safe Drinking Water Act. They are not federally enforceable but offer guidance to water systems and states on contaminant levels that protect public welfare. They are based on odor, aestheics, and appearence. They are listed at 40 CFR 143.

d. Drinking water health advisories are informal technical guidance issued by the U.S. EPA Office of Drinking Water (ODW).

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They are not legally enforceable standards. They are subject to change as new information becomes available. They are based on data describing noncarcinogenic endpoints. Lifetime health advisories describe concentrations of drinking water contaminants at which health effects would not be anticipated to occur over a lifetime exposure, accounting for other sources of exposure. No lifetime health advisories are issued for carcinogens. A "NRC" is indicated where health advisories have been issued for the chemical for less than lifetime exposures.

e. Based on ingestion of 1 liter/day by a 10 kg child. One day exposure.

f. Based on ingestion of 1 liter/day by a 10 kg child. Ten day exposure.

g. Longer term advisories based on ingestion of 1 liter/day for a 10-kg child and 2 liters/day for a 70-kg adult. Assumes an exposure of approximately 7 years, or 10 percent of an individual's lifetime.

h. Drinking Water Equivalent Level (DWEL): The medium specific (i.e. drinking water) lifetime exposure level assuming 100 percent exposure from that medium, at which adverse noncarcinogenic health effects would not be expected to occur. Based on ingestion of 2 liters/day for a 70 kg adult

i. Lifetime health adisories assumes that other sources besides water contribute to exposure. Where other source contributions are not known, a 20% drinking water contribution is assumed. Based on ingestion of 2 liters/day for a 70-kg adult.

j. Cancer groups B2/D

k. Under review

L Listed for regulation

m. When two or more aldicarb compounds are present, use MCL of 3ug/l for mixture. The health advisories are presently under review.

n. MCLs for total trihalomethanes (THM) including dibromochloromethane, bromoform and chloroform.

p. Treatment technique

TT Treatment technique

APPENDIX C
GROUNDWATER MONITORING WELL REQUIREMENTS, WISCONSIN ADMINISTRATIVE CODE NR 141

Chapter NR 141

GROUNDWATER MONITORING WELL REQUIREMENTS

NR 141.01 Purpose. The purpose of this chapter is to establish minimum acceptable standards for the design, installation, construction, abandonment and documentation of groundwater monitoring wells. These rules are adopted under chs. 144, 160 and 227, Stats.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.03 Applicability. This chapter applies to all persons installing and abandoning groundwater monitoring wells and boreholes for purposes regulated by the department under ch. 144, 147 or 160, Stats., or in permits, plan approvals, licenses or orders issued under those chapters. In addition, this chapter applies to all persons installing groundwater monitoring wells and boreholes in fulfillment of terms of a contract with the department. All wells and boreholes installed for purposes regulated by the department under this chapter shall be abandoned according to s. NR 141.25. All other wells and boreholes shall be abandoned according to the provisions of ch. NR 112.

Note: Additional requirements concerning soil testing and groundwater sampling are located in other chapters regulating wastewater and solid and hazardous waste disposal, see chs. NR 110, 206, 213, 214, 508, 512, 550 and the 600 series.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.05 Definitions. In this chapter:

(1) "Air rotary drilling" means a drilling method whereby the borehole is advanced using a circular rotating action applied to a string of drilling rods which have a diffused discharge bit attached to the bottom of the rods. Pressurized air is forced through the drilling rods and cools the drilling tools and removes the cuttings from the borehole.

(2) "Annular space seal" means the following:

(a) For wells constructed with filter packs, it is the material placed above the top of the filter pack or the filter pack seal up to the surface seal and between the well casing and the adjacent formation; or

(b) For wells constructed into bedrock formations and without well screens, it is the material placed from the bottom of the enlarged borehole up to the surface seal, between the well casing and the adjacent formation.

(2m) "Aquifer test well" means a well installed to provide information on the hydraulic conductivity, transmissivity, storage coefficient, capture zone, specific capacity, radius of influence or other physical parameters of an aquifer, defined geologic unit, or water bearing formation through the imposition of a sustained stress on the aquifer by removal of water.

(3) "ASTM" means american society for testing and materials.

(5) "Bedrock" means the solid rock underlying any loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

(6) "Bentonite" means a clay consisting of at least 85% sodium montmorillonite. Bentonite is available in the following forms:

(a) "Bentonite powder" means 200 mesh pure bentonite, without additives.

(b) "Bentonite granules" means 8 mesh pure bentonite, without additives.

(c) "Bentonite pellets" means commercially manufactured tablets made by compressing pure bentonite, without additives, into forms greater than ¼" in size.

(d) "Bentonite chips" means commercially processed angular fragments of pure bentonite, without additives.

(7) "Bentonite - cement grout" means a mixture with the ratio of 5 pounds of bentonite with 94 pounds of Portland cement and 8.5 gallons of water from a known safe and uncontaminated source.

(8) "Bentonite - fine sand slurry" means a mixture with the minimum ratio of 50 pounds of bentonite with 100 gallons of water from a known safe and uncontaminated source and 10-25% sand by volume for a mud weight of 11 pounds per gallon.

(9) "Borehole" means a circular hole deeper than it is wide, constructed in earth material for the purpose of either installing a well or obtaining geologic or groundwater related data. Boreholes are also referred to as drillholes.

(10) "Clay" means an inorganic soil with low permeability characteristics and a plasticity index of 7 or more.

(11) "Coarse sand" means a well sorted sand with a predominant grain size between 4.76mm and 2.0mm as established by the unified soil classification system.

(12) "Concrete" means a slurry mixture with a ratio of 94 pounds of cement, equal volumes of dry sand and gravel and 5 to 6 gallons of water from a known safe and uncontaminated source. The ratio of sand and gravel to cement may not exceed 3 parts to one.

(13) "Department" means the department of natural resources.

(14) "Driven point well" means a well constructed by joining a drive point with lengths of pipe and driving the assembly into the ground with

percussion equipment or by hand, without first removing material below the 10 foot depth,.

(15) "Filter pack" means the sand, gravel or both placed in direct contact with the well screen.

(16) "Filter pack seal" means the sealing material placed in the annular space above the filter pack and below the annular space seal to prevent the migration of annular space sealant into the filter pack.

(17) "Fine sand" means a well sorted sand with a predominant grain size between .42mm and .074mm, as established by the unified soil classification system.

(18) "Granular bentonite slurry" means a thoroughly blended mixture of up to 30 pounds of untreated bentonite powder added to 100 gallons of water from a known safe and uncontaminated source with a minimum of 100 pounds of untreated bentonite granules mixed together by a Venturi-hopper mud mixer or other equivalent high shear mixer.

(19) "Gravel" means an unconsolidated material with the predominant grain size being between 76.2mm and 4.76mm, as established by the unified soil classification system.

(20) "Groundwater" means any waters of the state, as defined in s. 144.01 (19), Stats., occurring in a saturated geologic formaton of rock or unconsolidated material.

(21) "Groundwater monitoring well" means any cased excavation or opening into the ground made by digging, boring, drilling, driving, jetting or other methods for the purpose of determining the physical, chemical, biological or radiological properties of groundwater. Groundwater monitoring wells may be piezometers, water table observation wells or both.

(21m) "High-solids grout" means a thoroughly blended mixture of water from a known safe and uncontaminated source with untreated bentonite, without additives, which has been approved by the department.

(22) "Hollow stem auger drilling" means a drilling method where continuous flighting is welded to a hollow stem pipe. The flighting carries drill cuttings to the surface as the flighting is rotated and pushed down into the earth.

(23) "Inside diameter" means the horizontal distance between the inner walls of a well casing, hollow stem auger or tremie pipe.

(24) "Medium sand" means a well sorted sand with a predominant grain size between 2.0mm and .42mm, as established by the unified soil classification system.

(25) "Montmorillonite" means a group of expanding lattice clay minerals of the general formula: $R_{.33}Al_2Si_4O_{10}(OH)_2 \cdot H_2O$, where R means one or more cations of sodium, potassium, magnesium or calcium and where Al means aluminum, Si means silicon, O means oxygen and H means hydrogen.

(26) "Mud rotary drilling" means a drilling method whereby a borehole is advanced by using a circular rotating action applied to a string of

drilling rods which have a diffused discharge bit attached to the bottom of the string. A bentonite and water mud slurry is used to provide borehole stability, to cool the bit and to carry cuttings to the ground surface.

(27) "Neat cement grout" means a slurry mixture with a ration of 94 pounds of Portland cement mixed with 5 to 6 gallons of water from a known safe and uncontaminated source.

(28) "Percussion drilling" means a drilling method using a cable tool drilling machine or a drilling method whereby the permanent or temporary well casing is driven, or is set into a borehole and then driven.

(29) "Permanent groundwater monitoring well" means any groundwater monitoring well in place for 60 days or longer.

(30) "Piezometer" means a groundwater monitoring well, sealed below the water table, installed for the specific purpose of determining either the elevation of the potentiometric surface or the physical, chemical, biological or radiological properties of groundwater at some point within the saturated zone or both.

(31) "Potentiometric surface" or "piezometric surface" means an imaginary surface representing the total head of groundwater and is the level to which water will rise in a well.

(32) "Psi" means pounds per square inch.

(33) "Purge" means an action that removes water from the well, commonly accomplished by using a pump or bailer.

(33m) "Recovery well" means a well intended and designed to capture and remove contaminated groundwater or non-aqueous phase liquids from the subsurface.

(34) "Rotary wash drilling" means a drilling method whereby metal temporary casing is advanced into the borehole by driving. At selected intervals, the temporary casing is cleaned out using rotary drilling tools by pumping clean water through the rod to flush out accumulated cuttings. This drilling method is also known as wash bore or wash down drilling.

(35) "Sand-cement grout" means a mixture of cement, sand and water in the proportion of 94 pounds of Portland cement, one cubic foot of dry sand and 5 to 6 gallons of water from a known safe and uncontaminated source.

(36) "Sediment" means any solid material dropping from suspension in water, including clay, silt, sand and gravel sized particles.

(37) "Solid stem auger drilling" means a drilling method where continuous flighting is welded onto a solid stem pipe. The flighting carries drill cuttings to the surface as the flighting is rotated and pushed down into the earth. The borehole is created by a cutting bit located at the tip of the lead auger.

(38) "Specific gravity" means the weight of a particular volume of substance compared to the weight of an equal volume of water at a reference temperature.

(39) "Surge" means an action causing water to move rapidly in and out of the well screen, thereby removing fine material from the surrounding aquifer.

(40) "Temporary groundwater monitoring well" means any groundwater monitoring well in place for less than 60 days.

(41) "Top of bedrock" or "top of firm rock" means at least 70% of the drill cuttings being either:

(a) Angular rock fragments, as in the case of crystalline rock; or

(b) Rock fragments composed of individual grains or rock particles that are cemented together to form an aggregate as opposed to a single sediment particle.

(42) "Tremie pipe" means a pipe or hose used to install well construction materials in an annular space or a borehole.

(43) "Unconsolidated material" means that material found above firm bedrock, composed of single sediment particles, individual grains or rock fragments. Unconsolidated material includes but is not limited to clay, silt, sand, gravel, loess, peat and organic soil.

(44) "Unified soil classification system" means the soil designation system based on the physical properties of the soil developed from the airfield classification system in 1952 and adopted by the American society for testing and materials in standard test method D2487-83.

Note: A copy of this publication is available for inspection at the offices of the department of natural resources, the secretary of state and the rivisor of statutes and may be obtained for personal use from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

(45) "Water table" means the surface of unconfined groundwater where the water pressure is equal to atmospheric pressure.

(46) "Water table observation well" means any groundwater monitoring well, in which the screen or open borehole intersects a water table, which is installed for the specific purpose of determining either the elevation of the water table or the physical, chemical, biological or radiological properties of groundwater at the water table or both.

Note: Construction of a typical water table observation well is depicted in Figure 1.

(47) "Well" means any borehole or other excavation or opening in the ground deeper than it is wide constructed for the purpose of obtaining or monitoring groundwater.

(48) "Well depth" means the distance from the ground surface to the bottom of the well screen or to the bottom of the open hole when a well screen is not used.

(49) "Well volume" means the volume of water contained in the well casing and the filter pack.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (7), (8) and (18), cr. (2m), (21m) and (33m), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.055 Borehole protection. If a borehole is left open, protective measures shall be taken to prevent the borehole from acting as a conduit for contamination or becoming a safety hazard.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.06 Soil testing. Specific soil sampling and testing procedures are specified in other chapters related to wastewater and solid and hazardous waste disposal facilities.

Note: See chs. NR 110, 181, 206, 214, 508, 512 and 550.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.065 Well location. (1) Monitoring wells installed where prior department approval is required shall be installed at the locations indicated on plans and specifications approved by the department prior to installation.

(2) Following installation of the wells, an as-built plan map shall be submitted specifying the exact vertical and horizontal location of the wells. All monitoring well locations shall be reported to the department on a plan map drawn to a specific scale. The map shall indicate structure boundaries, property boundaries, any nearby surface waters and a north arrow. The plan shall show the wells in relation to each other, to property and structure boundaries, and to a common reference point on a horizontal grid system. The origin of the grid system shall be located according to latitude and longitude or according to the state plane coordinate system. The exact vertical location of the top of the well casing shall be referenced to the nearest benchmark for the national geodetic survey datum to an accuracy of 0.01 feet. This plan map shall show the exact location of the installed well on a horizontal grid system which is accurate to within one foot. Direction of groundwater flow shall be indicated. In addition, an 8.5-inch by 11-inch site map drawn to scale according to the horizontal grid system shall be submitted showing the location of wells and structures on the site.

(3) The well casings for wells constructed in a floodplain or floodway shall terminate a minimum of 2 feet above the regional flood elevation for the well site.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (2), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.07 Well casing. (1) SPECIFICATIONS. All permanent groundwater monitoring wells shall be constructed of new polyvinyl chloride (PVC) well casing materials except in situations where the rock, soil or groundwater may react with PVC, in which case an approval under s. NR 141.31 for alternative materials shall be requested. All PVC casing materials shall meet national sanitation foundation standard 14 and ASTM D1785 specifications for any one of the following cell classifications: 12454-B, 12454-C, 11443-B, 14333-D, 13233 or 15223-B. All casing shall have a minimum inside diameter of 1.9 inches. In unconsolidated geologic formations, all wells less than or equal to 100 feet in depth shall be constructed of at least schedule 40 PVC casing and all wells greater than 100 feet in depth shall be constructed of at least schedule 80 PVC casing. Groundwater monitoring wells shall be installed with well casing no larger than a 4-inch inside diameter. Groundwater monitoring wells shall have a vented cap except as provided in s. NR 141.13 (4) (b).

(2) REFERENCE. The listed national sanitation foundation and ASTM references are available for inspection at the offices of the department of natural resources, the secretary of state and the revisor of statutes and may be obtained for personal use from the National Sanitation Foundation, 3475 Plymouth Road, P.O. Box 1468, Ann Arbor, Michigan 48106, and the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

(3) ASSEMBLY AND INSTALLATION. All casing couplings shall be constructed of flush threaded joints. Solvent welded joints may not be used without prior written approval by the department. The casing shall be centered in the borehole.

(4) INSPECTION. Prior to use, the casings and couplings shall be inspected for cuts, deformations, gouges, deep scratches, damaged ends and other imperfections. Any casing or coupling having such a defect may not be used.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1), Register, June, 1991, No. 426, eff. 7-1-91.

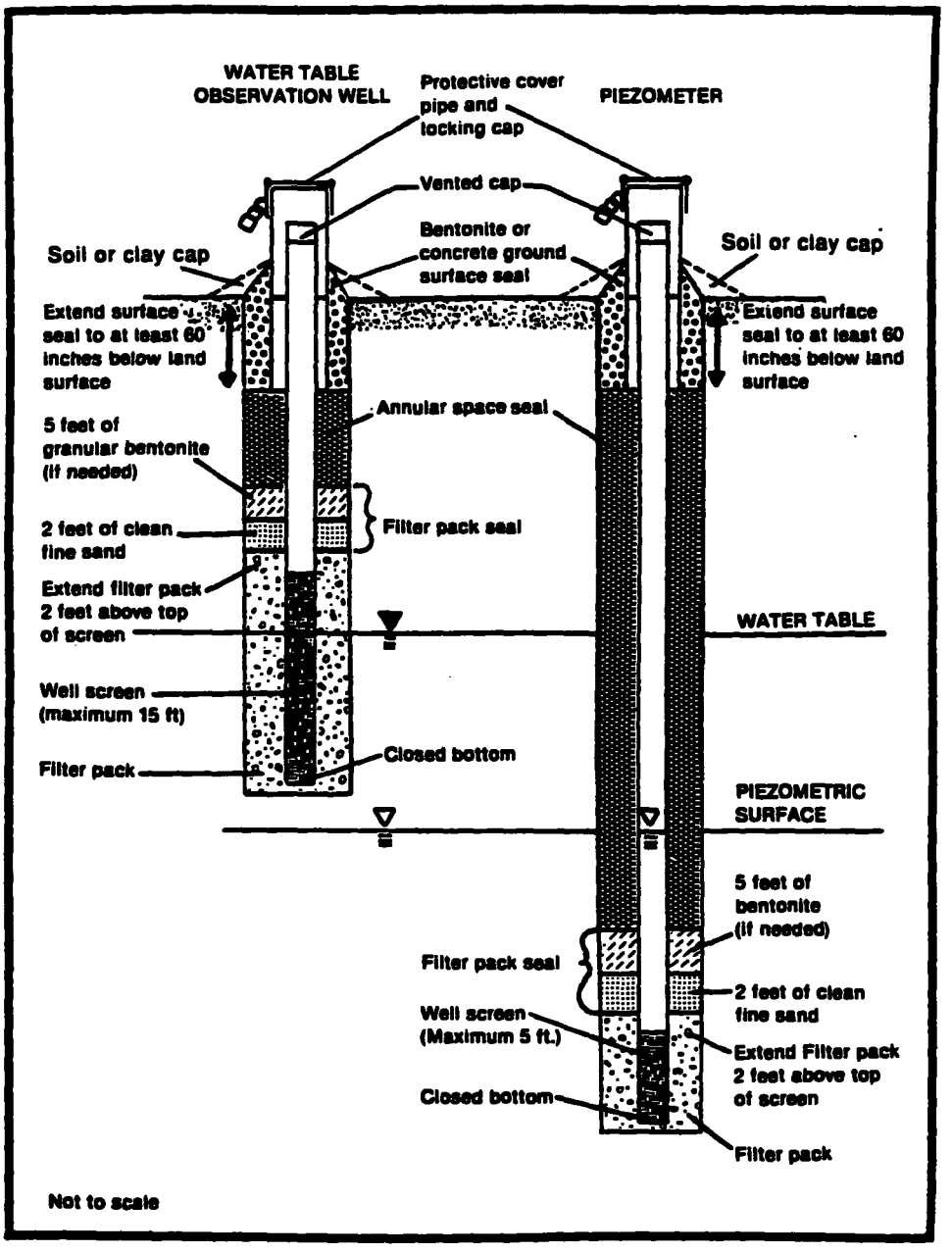
NR 141.09 Well screen. (1) SPECIFICATIONS. All permanent groundwater monitoring well screens shall be constructed of material which is nonreactive with the constituents in soils and groundwater at the monitoring location. The well screen may not be hand cut and may not be wrapped with filter cloth. The well screen slot size shall be sized to retain at least 90% of the grain size of the collapsed formation, based on a sieve analysis, when collapsed formation is used as filter pack material or at least 90% of the grain size of the filter pack, based on a sieve analysis, if material other than collapsed formation is used. Well screens on water table observation wells may not exceed 15 feet in length. Well screens on piezometers installed for the purpose of determining the elevation of the potentiometric surface may not exceed 5 feet in length.

Note: Well screens for wells other than the water table observation wells and piezometers identified above may vary in length.

(2) ASSEMBLY AND INSTALLATION. All well screens shall be permanently joined to the well casing by flush threaded joints. All joints shall be watertight. All well screens shall be centered in the borehole. Monitoring wells installed in bedrock using an open borehole may be constructed without a well screen.

Figure 1. . . .

Typical water table observation well and piezometer construction details.



History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.10 Tremie pipes and sealing procedures. (1) MATERIALS. The tremie pipe used for the placement of sealant materials shall be one of the following materials:

(a) Metal pipe,

(b) Rubber-covered hose reinforced with braided fiber or steel and rated for at least 300 psi, or

(c) Thermoplastic pipe rated for at least 100 psi including:

1. Polyvinyl chloride (PVC)

2. Chlorinated polyvinyl chloride (CPVC),

3. Polyethylene (PE),

4. Polybutylene (PB), and

5. Acrylonitrite butadiene styrene (ABS).

(2) PROCEDURES. This subsection describes department approved sealant placement methods when a tremie pipe is used.

(a) The estimated and actual volume of sealing material used shall be calculated and reported to the department.

(b) The sealant material shall be placed in one continuous operation in such a manner as to not disturb the integrity of the filter pack and seal.

(c) When a tremie pipe is used, the bottom end shall be kept submerged in the sealant material throughout the sealing process.

(d) The sealant material shall be brought up to the ground surface seal. The density of the sealant material in the annular space or borehole at the bottom of the ground surface seal shall be the same as the density of the sealant material being placed. Any settling of the sealant material shall be topped off.

(e) Tremie pipe - gravity. As depicted in Figure 2, sealing material may flow by gravity through a funnel or hopper connected to a tremie pipe. The tremie pipe shall be lowered to the bottom of the annular space or borehole to be sealed and the sealing material placed from the bottom up. The end of the tremie pipe shall be kept submerged in the grout or slurry at all times.

(f) Tremie pipe - pumped. As depicted in Figure 3, the sealing material shall be placed by a pump through a tremie pipe into the annular space or borehole. Tremie pipes used for the placing of pumped slurry or grout shall be fitted with a J-hook end or a closed end with side discharge ports.

Note: The J-hook end or closed end with side discharge ports of the tremie pipe will direct the flow of the materials to the side or upward.

Figure 2.

Conductor (tremie) pipe — gravity method

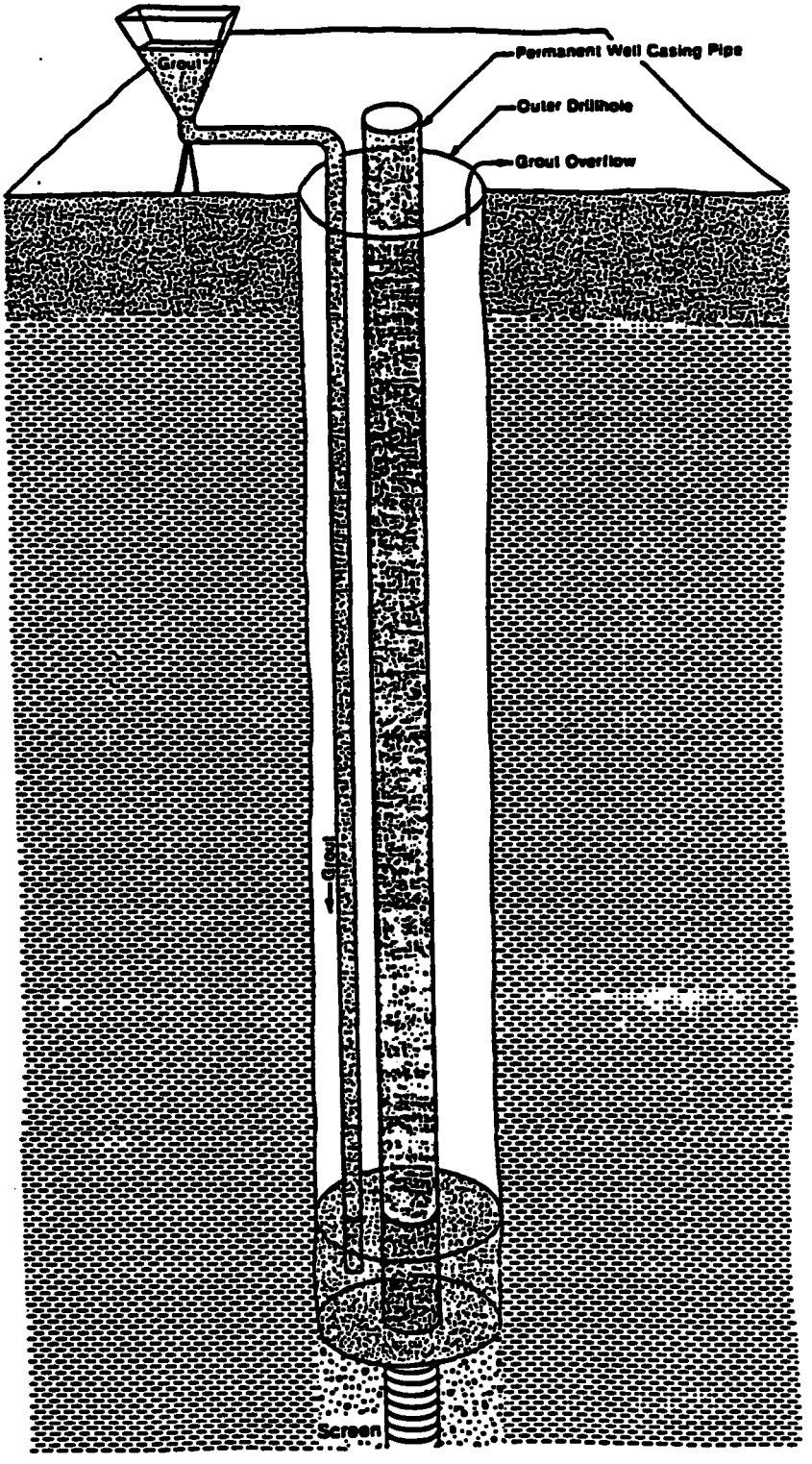
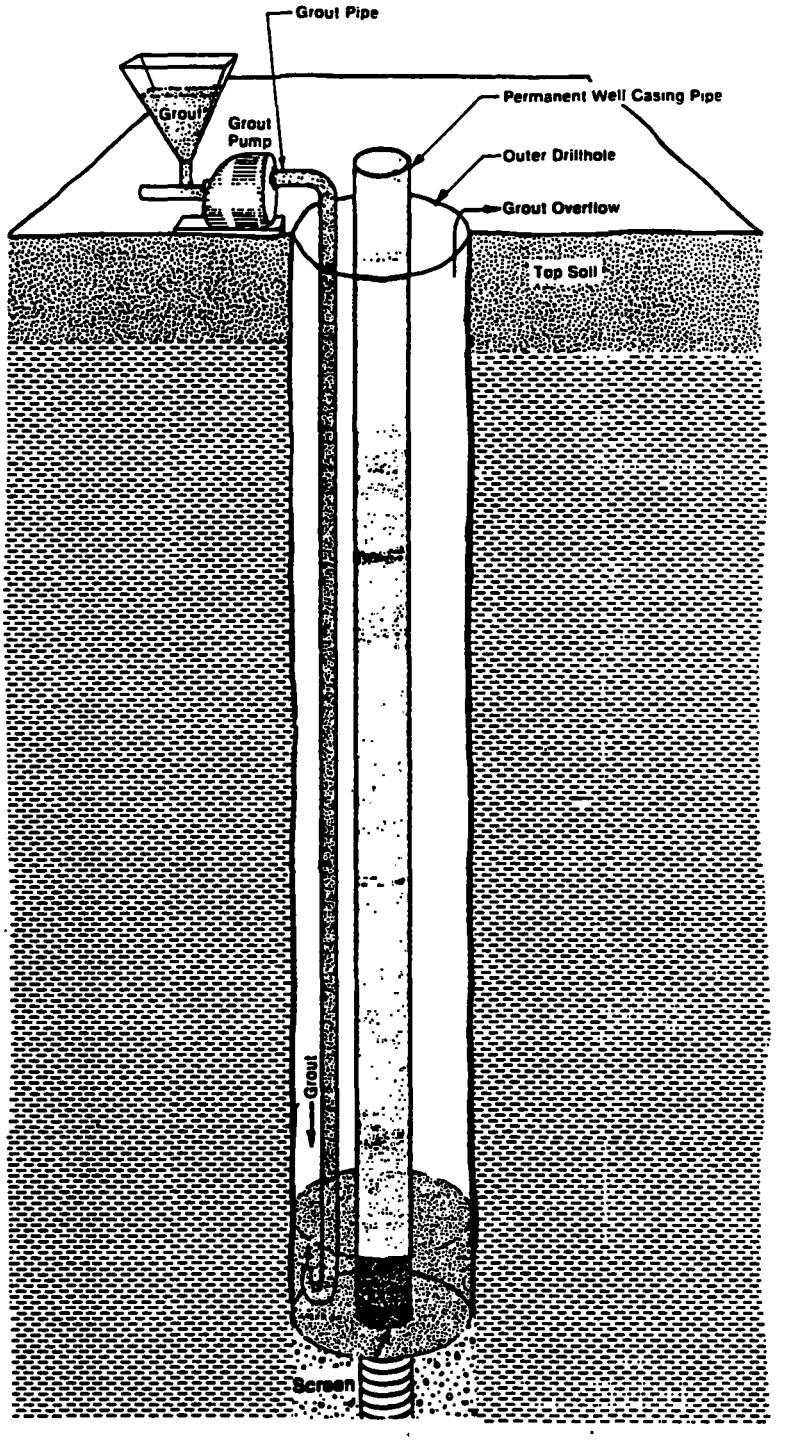


Figure 3.

Conductor (tremie) pipe — pumped method



History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (2) (d) and (f), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.11 Filter packs. All permanent groundwater monitoring wells installed in unconsolidated material and used for the collection of water quality samples shall be constructed with filter packs. Permanent groundwater monitoring wells installed in bedrock may be constructed with filter packs. When used, the filter pack shall be the only material in contact with the well screen. The estimated and actual volume of filter pack material used shall be calculated and reported to the department. All commercially prepared filter packs installed in permanent groundwater monitoring wells shall meet the requirements in sub. (1). All other filter packs shall meet the requirements in sub. (3).

(1) SPECIFICATIONS. The filter pack shall be a well sorted, silica based sand or gravel. The sand or gravel used for filter packs shall be hard and durable and shall have an average specific gravity of not less than 2.50. The sand and gravel shall be visibly free of clay, dust and micaceous and organic matter. Not more than 5% of the sand or gravel shall be soluble in a 10% hydrochloric acid solution. Thin, flat or elongated pieces of gravel, the maximum dimension of which exceeds 3 times the minimum dimension, may not constitute more than 2% of the material by weight. The filter pack for wells installed in unconsolidated material shall be sized to retain at least 50% of the surrounding formation based on a sieve analysis. In formations which are predominantly silt and clay, the filter pack shall be a fine sand. In bedrock, the filter pack shall be a medium or coarse sand or gravel. Crushed limestone, dolomite or any material containing clay or any other material that will adversely impact on the performance of the monitoring well may not be used as filter pack.

(2) INSTALLATION. The filter pack shall extend from 6 inches beneath the bottom of the well to 2 feet above the top of the well screen. For water table observation wells constructed in areas where the depth to water table is less than 7 feet, the required filter pack height above the top of the well screen may be reduced to 6 inches to allow for the required amount of annular space sealant to be placed. To ensure that the filter pack is installed evenly surrounding the well screen and casing over the proper depth interval, a tape measure, measurng rod or similar device shall be used to measure the height of the filter pack. The tape measure, measuring rod or similar device shall be carefully raised and lowered while the filter pack is being installed to identify bridging. If bridging occurs the filter pack material shall be tamped into place, surrounding the well screen and casing, using a measuring rod or similar device.

(3) COLLAPSED FORMATION. Collapsed formation may be used as filter pack material if the collapsed formation will limit the passage of formation fines into the well screen and either an artificial filter pack cannot be installed or the formation grain size is greater than or equal to fine sand sized grains. The grain size distribution of the collapsed formation shall be such that at least 90% of the formation will be retained by the well screen based on a sieve analysis. Analysis of the collapsed formation for specific gravity and particle size shall be performed and documentation shall be submitted to the department to support its use as an acceptable filter pack. Following review of the submitted information, the department may require new well construction if the collapsed formation analysis is not consistent with the filter pack specifications.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1) to (3), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.13 Sealing requirements. All materials and procedures used in the installation of seals for permanent groundwater monitoring wells shall meet the requirements of this section. The calculated and actual volume of sealant material used for the filter pack seal and annular space seal shall be reported to the department.

(1) FILTER PACK SEAL. (a) *Specifications.* All permanent groundwater monitoring wells installed with filter packs shall be constructed with a filter pack seal. For all water table observation wells and piezometers, the filter pack seal shall extend 2 feet upward from the top of the filter pack and shall consist of 2 feet of clean fine sand. When high-solids grout, granular bentonite slurry, bentonite-cement grout or neat cement grout is used as the annular space sealant, 5 feet of bentonite shall be placed on top of the clean fine sand seal. Bentonite chips no greater than ⅜ inch in diameter or bentonite pellets shall be used for seals placed below the water table. Bentonite granules may be used for seals when there is no standing water above the filter pack and the borehole is less than 25 feet or in areas where the depth to water table is less than 7 feet. For water table observation wells constructed in areas where the depth to water table is less than 16 feet, the filter pack seal shall be reduced to 2 feet of bentonite to allow for the required amount of annular space sealant to be placed. For water table observation wells constructed in areas where the depth to water table is less than 7 feet, the required fitler pack seal may be reduced to allow for the required amount of annular space sealant to be placed.

(b) *Installation.* A tape measure, measuring rod or similar device shall be used to ensure that the filter pack seal is installed over the proper depth interval. The tape measure, measuring rod or similar device shall be carefully raised and lowered while the filter pack seal material is being placed to identify bridging. If bridging occurs the filter pack seal material shall be tamped into place, surrounding the well casing, using a measuring rod or similar device. When a tremie pipe is used to place the filter pack seal the procedures of s. NR 141.10 (2) shall be followed. Bentonite pellets, bentonite chips or bentonite granules shall be hydrated in 2 foot lifts as placed in the borehole when placed above the water table.

(2) ANNULAR SPACE SEAL. (a) *Specifications.* All permanent groundwater monitoring wells shall be installed with an annular space seal designed to achieve a permeability of 1×10^{-7} centimeters per second or less. For permanent groundwater monitoring wells constructed with filter packs, the annular space seal shall extend from the filter pack seal to the ground surface seal and shall be at least 2 feet in length. For water table observation wells constructed in areas where the depth to water table is less than 7 feet, the annular space seal shall be bentonite granules. For monitoring wells constructed into bedrock formations and without well screens, the annular space seal shall extend from the bottom of the outer borehole to the ground surface seal and shall be at least 2 feet in length. Sealant materials may not contain additives. These requirements may be met by:

Note: The department does not recommend the use of neat cement grout or cement mixtures in fractured formations because they may impact water quality.

1. Bentonite granules slurry may be used as an annular space sealant in any type of monitoring well except where the depth to the water table is less than 7 feet.

2. Bentonite sand slurry may be used as an annular space sealant in any type of monitoring well except where the depth to the water table is less than 7 feet.

3. Bentonite pellets, bentonite chips or bentonite granules may be used to seal the annular space under the following conditions:

a. Bentonite granules may be used when there is no standing water in the well above the filter pack and the total well depth is less than 25 feet or the depth to water table is less than 7 feet.

b. Bentonite chips with diameter no larger than ¾ inch or bentonite pellets may be used when the depth of standing water in the well is less than 30 feet and the total depth of the annular space seal is less than 50 feet except where the depth to the water table is less than 7 feet.

4. High-solids grout approved by the department, bentonite-cement grout or neat-cement grout may be used to seal the annular space in which a bentonite filter pack seal has been placed except where the depth to the water table is less than 7 feet.

(b) *Installation.* 1. When bentonite chips with diameter no larger than ¾ inch, bentonite pellets or granules are used to seal the annular space, they may either be poured freely down the borehole or added through a tremie pipe, provided the specifications of par. (a) are met. When a tremie pipe is used to place the annular space sealant the procedures of s. NR 141.10 (2) (a) and (b) shall be followed.

2. When grouts or slurries are used to seal the annular space, the material may be poured freely down a tremie pipe or pumped down a borehole with the use of a tremie pipe, provided the specifications of par. (a) are met. For wells 100 feet in depth or greater the sealant material shall be pumped down the borehole with the use of a tremie pipe. When a tremie pipe is used to place the annular space sealant the procedures of s. NR 141.10 (2) shall be followed.

3. When any slurry or grout is used, there shall be a 12-hour period between the time the annular space seal is installed and the time the protective cover pipe is installed. Any settling in the annular space seal shall be topped off before the protective cover pipe is installed.

4. The top of the well casing shall be covered with a protective cap.

(3) GROUND SURFACE SEAL AND PROTECTIVE COVER PIPE. (a) *Ground surface seal.* All permanent groundwater monitoring wells shall be constructed with a bentonite or concrete ground surface seal. The ground surface seal shall extend to a minimum of 60 inches below the land surface, and the top shall be sloped away from the well casing. If bentonite is used, the top of the surface seal shall terminate 2 inches below the land surface and shall be covered with top soil or native soil to prevent drying out. The ground surface seal shall be installed around the protective cover and may not be placed between the protective cover pipe and the well casing. If the monitoring well depth is such that both a minimum 2 foot annular space seal and a minimum 5 foot ground surface seal cannot both be placed, the ground surface seal may be shortened.

Note: Certain soils are prone to frost heave and the department does not recommend use of concrete as a ground surface seal in these situations.

(b) *Protective cover pipe.* The protective cover pipe shall consist of a metal casing at least 2 inches larger in diameter than the well casing with a locking cap. The protective cover pipe shall extend from the bottom of the ground surface seal to a minimum of 24 inches above the ground surface except as provided in sub. (4). There may be no more than 4 inches between the top of the well casing and the top of the protective cover pipe. The protective cover pipe shall always extend above the top of the well casing. For water table observation wells constructed in areas where the depth to water table is less than 7 feet, the required length of protective cover shall be reduced and may not extend through the annular space seal or into the filter pack. If the monitoring well is located in a floodplain, the protective cover pipe shall be watertight. The department may require additional protective devices, such as rings of brightly colored posts around the well, as necessary. Weep holes or vents may be used in protective cover pipes.

(4) GROUND SURFACE SEAL AND FLUSH MOUNTED PROTECTIVE COVER PIPE. (a) *Ground surface seal.* All permanent groundwater monitoring wells with a flush mounted protective cover pipe shall be constructed with a concrete ground surface seal. The ground surface seal shall extend to, but not beyond, the total depth of the flush mounted protective cover pipe. The ground surface seal shall be installed around the flush mounted protective cover pipe and may not be placed between the flush mounted protective cover pipe and the well casing.

(b) *Flush mounted protective cover pipe.* The flush mounted protective cover pipe may be installed only in high vehicular traffic areas and may not be installed in areas subject to ponding or flooding. The flush mounted protective cover's lid shall have the wording "monitoring well" on its outer surface. Flush mounted protective cover pipes shall be installed through an impervious surface such as asphalt or concrete. If an impervious surface does not exist one shall be created which will support the weight of the traffic in the area. The flush mounted protective cover pipe shall consist of a watertight metal casing with an inside diameter at least 4 inches greater than the inside diameter of the monitoring well casing. The flush mounted protective cover pipe shall be one continuous metal piece or 2 metal pieces which are joined with a continuous weld. The flush mounted protective cover pipe shall be a minimum of 12 inches in length. There may be no more than 8 inches between the top of the monitoring well casing and the top of the flush mounted protective cover pipe after installation. The flush mounted protective cover pipe shall have an exterior flange or lugs. The flush mounted protective cover pipe may not extend beyond the annular space seal. The flush mounted protective cover pipe or the monitoring well shall have a locking mechanism. The monitoring well installed within any flush mounted protective cover pipe shall have a watertight cap.

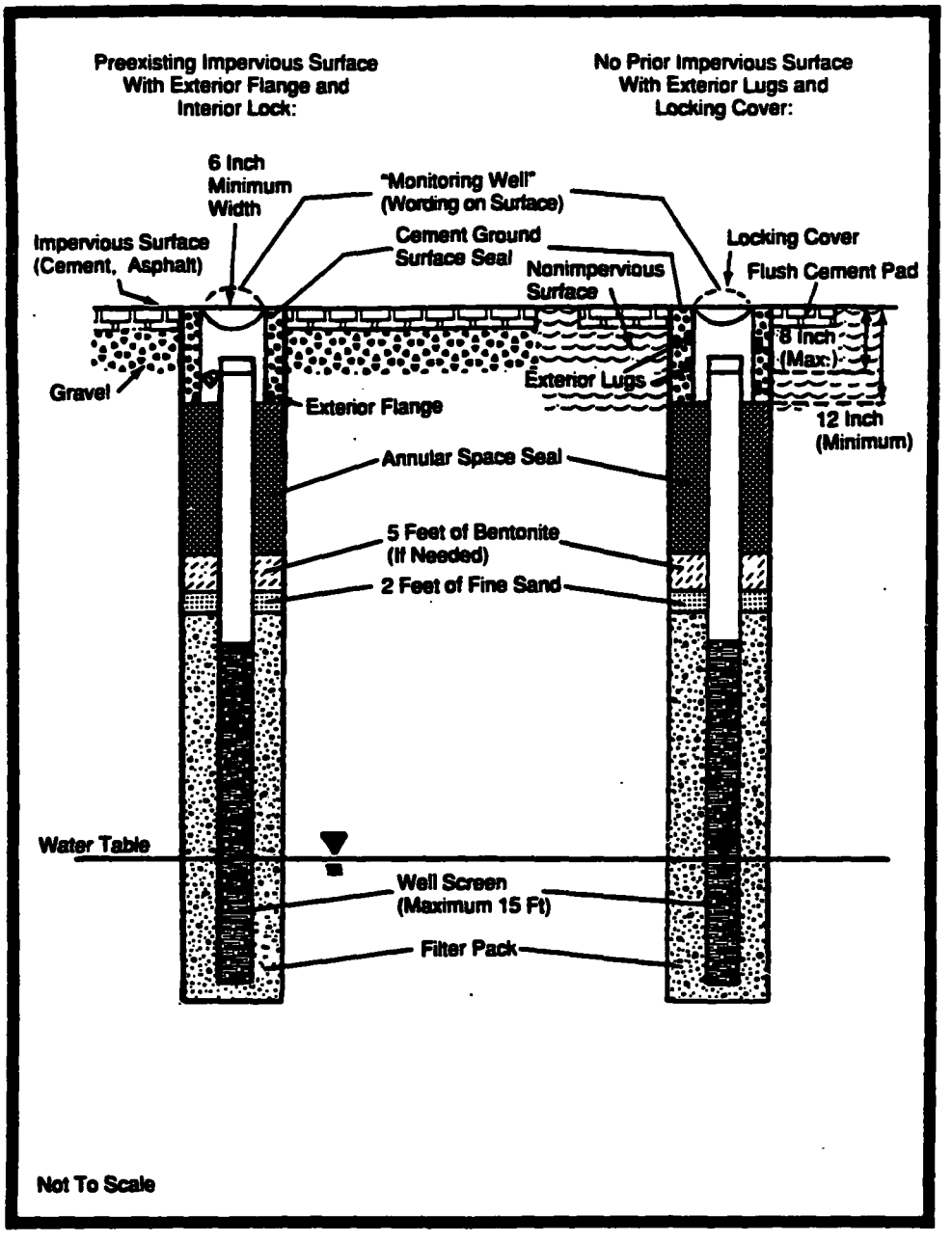
Note: Figure 4 depicts 2 typical flush mounted protective cover pipes after installation.

Note: An exterior flange or lugs will aid in the stabilization of the flush mounted protective cover pipe within the ground surface seal.

Note: After removing the watertight cap and prior to taking a pressure head measurment a waiting period is recommended to enable the water level to stabilize.

Figure 4.

Two typical flush mounted protective cover pipes after installation.



History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1), (2) (a) (intro.), 1., 2. and 3. and (b) 1. and 4. and (3), r. and recr. (2) (a) 4., r. (2) (a) 5. and 6., cr. (4), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.15 Drilling methods and fluids. The drilling method shall introduce the least possible amount of foreign material into the borehole, produce the least possible disturbance to the formation and permit the proper construction and development of the required diameter well. Only air, water from a known safe source free of bacterial and chemical contamination or bentonite drilling muds, mixed with water from a known safe and uncontaminated source, may be used as drilling fluids. The water used for drilling shall be stored in such a manner as to prevent contamination of the clean water. The department may require chemical analysis of the water used to produce drilling fluids. Hammer drill lubricants, used with air rotary drill rigs, may not be used for installing groundwater monitoring wells. If air is used as a drilling fluid, the air shall be filtered by a coalescing air filter. If water is used, the source of the water shall be reported. Drilling fluid additives may not be used without prior written department approval.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.16 Cross contamination. Precautions shall be taken to prevent cross contamination of aquifers or uncontaminated zones.

History: Cr. Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.17 Disposal and decontamination. (1) All drill cuttings and fluids and surge and wash waters from borehole and groundwater monitoring well construction and development shall be disposed of in a manner approved by the department.

(2) All borehole and groundwater monitoring well construction and development equipment shall be decontaminated by washing and triple rinsing or high pressure heat cleaning to prevent cross-contamination of boreholes or groundwater monitoring wells.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.19 Borehole diameter. (1) BOREHOLES IN UNCONSOLIDATED GEOLOGIC FORMATION. For all permanent groundwater monitoring wells in unconsolidated geologic formations, the borehole diameter shall meet the following requirements:

(a) If hollow stem augers are used, their inside working diameter shall be at least 2¼ inches greater than the inside diameter of the permanent well casing.

(b) If solid stem augers are used, their outside diameter shall be at least 4 inches greater than the inside diameter of the permanent well casing.

(c) If an air or mud rotary method is used, the borehole diameter shall be at least 4 inches greater than the inside diameter of the permanent well casing. If a temporary outer casing is used, the inside diameter of the temporary outer well casing shall be at least 4 inches greater than the inside diameter of the permanent well casing. The temporary outer casing shall be pulled as the annular space is being sealed.

Note: The dual-tube or triple-tube reverse rotary systems are rotary methods.

(d) If percussion methods, including the rotary wash, wash down and wash bore methods, with a temporary outer casing are used, in unconsolidated geologic formations, the inside diameter of the temporary outer casing shall be at least 4 inches greater than the inside diameter of the

permanent well casing. The temporary outer casing shall be removed during the sealing of the annular space.

(2) BOREHOLES IN BEDROCK GEOLOGIC FORMATIONS. For all permanent groundwater monitoring wells installed deeper than 2 feet past the top of the bedrock, the borehole diameter shall meet the following requirements:

(a) If an air or mud rotary method is used to construct the monitoring well, the requirements of sub. (1) (c) shall be followed.

(b) If percussion methods are used to construct the monitoring well, the requirements of sub. (1) (d) shall be followed.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.20 Aquifer test or recovery wells. The installation, location and construction of any aquifer test well or recovery well installed for a purpose regulated by the department under ch. 144, 147 or 160, Stats., shall be approved by the department program responsible for overseeing work at the site prior to installation. Unless another time period is specified by law, the department shall complete its review and make a determination on all applications for approval within 65 business days after receipt of the complete application for approval. Applications may be included with other submittals for work to be performed at the site. The start of the 65 day review period will not begin until a complete application is received by the department. All requests for approval shall be in writing, except that for situations that require immediate response, an approval may be requested verbally and an advanced verbal approval may be granted by the department and followed up with a written confirmation. Aquifer test wells or recovery wells may be used for pressure head monitoring or water quality monitoring only with the approval of the department. All aquifer test and recovery wells shall be abandoned according to s. NR 141.25 and documented according to s. NR 141.23.

Note: See ch. NR 112 for additional requirements that apply to aquifer test wells and recovery wells.

History: Cr. Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.21 Well development. All permanent groundwater monitoring wells shall be developed according to the requirements of section. Wells sealed with grout or slurry shall be developed after a minimum waiting period of 12 hours after installation is completed. The goal of well development is to produce water free of sediment and all drill cuttings and drilling fluids.

(1) WELLS THAT CANNOT BE PURGED DRY. All permanent groundwater monitoring wells that cannot be purged dry shall be developed by the following procedure:

(a) Alternately surge and purge the well for a minimum of 30 minutes. The surge and purge cycle shall consist of several minutes of surging followed by several minutes of purging to remove the material collecting in the bottom of the well. The surging shall move formation water in and out of the well screen. The surging shall be accomplished by using either a bailer or surge block or by pumping the well sufficiently to cause a drawdown and then allowing the well to recover and repeating the process.

Note: When a surge block is used, care should be taken to avoid drawing the annular space seal material into the filter pack or well screen.

(b) After the final surge and purge cycle is completed, the well shall be pumped or bailed until 10 well volumes of water are removed or until the well produces sediment free water. If sediment free water is not obtained any remaining sediment shall be removed from the bottom of the well. Well volume shall be calculated in the following manner:

$V_1 + V_2$ = well volume

V_1 = volume of water in well casing

$$V_1 = \Pi \left(\frac{D}{2}_1\right)^2 H_1 \bullet$$

V_2 = volume of water in filter pack

$$V_2 = N \Pi H_2 \left[\left(\frac{D}{2}_3\right)^2 - \left(\frac{D}{2}_2\right)^2\right]$$

N = porosity of filter pack

D_1 = inside diameter of well casing

D_2 = outside diameter of well casing

D_3 = diameter of borehole

H_1 = height of water column

H_2 = length of sand used in filter pack and fine sand filter pack seal or the height of the water column in water table observation wells.

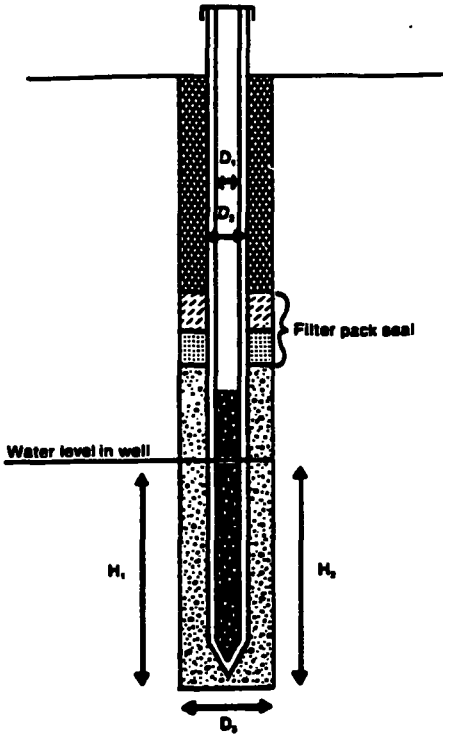
Note: There are 7.48 gallons per cubic foot.

H_1 = height of water column

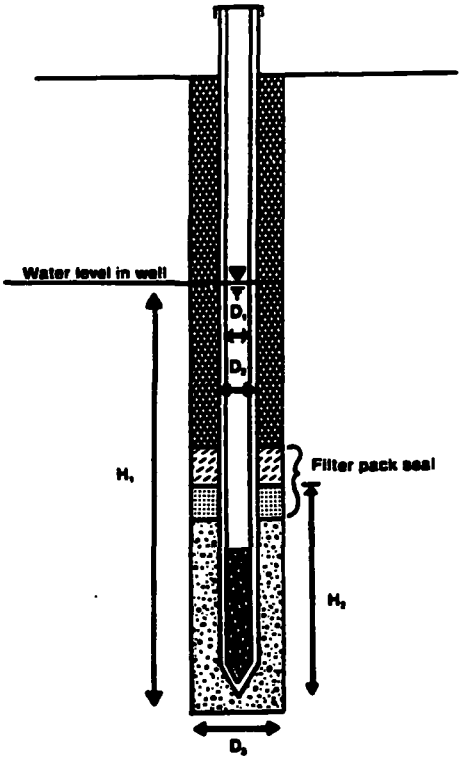
H_2 = length of filter pack or the height of the water column in water table observation wells.

CALCULATION OF WELL VOLUME

IN WATER TABLE OBSERVATION WELL



IN PIEZOMETER



(2) WELLS THAT CAN BE PURGED DRY. All permanent groundwater monitoring wells that can be purged dry shall be developed in a manner which limits agitation by slowly purging the well dry. Wells which can be purged dry may not be surged and no water may be added to the well.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (intro.), (1) (a) and (b) and (2), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.23 Well and borehole construction documentation. (1) All permanent groundwater monitoring well construction shall be reported to the department, using forms and instructions provided by the department, within 60 days after the well has been installed. The completed report shall include the following information:

(a) Well location,

(b) Well casing material and installation procedures,

(c) Well screen materials and installation procedures,

(d) Filter pack materials and installation procedures,

(e) Sealing materials and installation procedures,

(f) Drilling methods and fluids used for installation,

(g) Borehole diameter,

(h) Well development procedures,

(i) Sieve analysis, and

(j) Any other information deemed necessary by the department.

(2) All permanent groundwater monitoring wells installed after February 1, 1990 shall be labeled with labels supplied by the department.

(3) All borehole construction data shall be reported to the department using forms and instructions supplied by the department within 60 days after construction. The completed report shall include the following data: the results of any soil tests done and a description of the soil structure, soil color, mottling, moisture content, layering, jointing, lenses, fractures, organic matter and voids and any other information deemed necessary by the department. The constructor shall report any decontamination procedures used between borehole installations.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (1) (h), renum. (1) (i) to (j), cr. (1) (i), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.25 Abandonment requirements. The following requirements apply to the abandonment of all boreholes greater than 10 feet deep or which intersect a water table and all groundwater monitoring wells. The department may require, by order or other appropriate means, that any borehole or monitoring well be abandoned. The department shall consider the following factors in determining whether a borehole or monitoring well should be abandoned: purpose, location, groundwater quality, age and condition of the well or borehole potential for groundwater contamination and well or borehole construction.

(1) TIMELINES FOR ABANDONMENT. (a) A borehole shall be abandoned within 3 working days after its use has been discontinued.

(b) Any permanent groundwater monitoring well no longer being used to gather information on geologic or groundwater properties shall be abandoned within 60 days after its use has been discontinued.

(c) Any groundwater monitoring well found by the department to be acting as a conduit for groundwater contamination shall be abandoned within 15 working days after written notification by the department.

(d) Any groundwater monitoring well constructed after February 1, 1990 not meeting the requirements of this chapter shall be abandoned and replaced with a monitoring well meeting the requirements of this chapter or any department approval granted under this chapter within 60 days after installation of the noncomplying well or 15 days after written notification by the department that the well is noncomplying.

(2) ABANDONMENT PROCEDURES. (a) *Boreholes.* Any borehole intersecting the water table or greater than 10 feet deep, whose use has been discontinued, shall be abandoned according to the requirements of par. (d).

(b) *Monitoring wells - impermeable annular space seals.* A permanent groundwater monitoring well known to be constructed with an impermeable annular space seal shall be abandoned according to the requirements of par. (d) after the protective cover pipe and ground surface seal have been removed and the well casing cut off at least 30 inches below the ground surface. The well casing may be completely removed during abandonment by pulling the well casing, overdrilling around the casing and then pulling the well casing out of the ground or by drilling out the well casing completely. If the well casing is to be removed, the well shall be sealed as the casing is removed.

(c) *Monitoring wells - permeable annular space seals and wells in waste areas.* A groundwater monitoring well not known to be constructed with an impermeable annular space seal or located in an existing or planned future waste disposal or treatment area shall be abandoned by removing the protective cover pipe and the ground surface seal and then completely removing the well casing. The well casing shall be pulled out of the ground as the well is filled according to the requirements of par. (d).

(d) *Sealing requirements.* Boreholes and groundwater monitoring wells shall be abandoned by complete filling with neat cement grout, bentonite-cement grout, sand-cement grout, concrete or bentonite-sand slurry. When a tremie pipe is used to place the sealing material, the procedures of s. NR 141.10 (2) shall be followed. A tremie pipe shall be used to abandon groundwater wells and boreholes greater than 30 feet in depth or with standing water. Groundwater monitoring wells and boreholes greater than 100 feet in depth shall be sealed with a tremie pipe-pumped method. Bentonite may be used as a sealing material without the use of a tremie pipe under the following conditions:

1. Bentonite granules may be used for abandonment of boreholes and groundwater monitoring wells less than 25 feet deep and when there is no standing water above the filter pack seal.

2. Bentonite chips no greater than ¾ inch in diameter or bentonite pellets may be used for abandonment of boreholes and groundwater monitoring wells less than 50 feet deep and the depth of standing water is less than 30 feet.

3. Bentonite chips no greater than ⅜ inch in diameter or bentonite pellets may be used for abandonment of boreholes and groundwater monitoring wells which are greater than 4 inches in diameter and less than 250 feet deep and the depth of standing water is less than 150 feet.

(3) SEALANT SETTLEMENT. Any settling of the sealant material shall be topped off. Sealing material may be terminated 30 inches below the ground surface in agricultural areas to avoid interference with agricultural activities. A native soil plug shall be placed on top of the settled sealing material in such cases.

(4) ABANDONMENT DOCUMENTATION. All borehole and permanent groundwater monitoring well abandonments shall be reported to the department within 60 days of the abandonment on forms supplied by the department. In addition to the information required on the form, the person performing the abandonment shall report any decontamination procedures used between borehole and well abandonments.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90; am. (2) (b), (2) (d) 1 to 3 and (3), Register, June, 1991, No. 426, eff. 7-1-91.

NR 141.27 Driven point wells. Driven point wells with galvanized steel drive pipes and contaminant compatible well screens may be used as permanent groundwater monitoring wells if prior department approval is obtained. Written documentation shall be supplied to the department prior to installation indicating:

(1) That the well is to be used only for water table elevation measurements or to monitor for parameters for which the well casing and screen material will not interfere with the analytical results;

(2) That the well will not provide a conduit for contaminants to enter the groundwater; and

(3) That information on subsurface stratigraphy is not needed. In situations where subsurface geologic information is needed, a separate borehole shall be constructed to collect the required data.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.29 Temporary groundwater monitoring wells. Temporary groundwater monitoring wells may be installed according to less stringent standards than specified for permanent groundwater monitoring wells. Any temporary monitoring well construction shall be approved by the department prior to its installation. All temporary monitoring wells shall be abandoned in accordance with s. NR 141.25 within 120 days after their installation.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

NR 141.31 Special circumstances and exceptions. (1) The department may require or approve more restrictive or alternative well material, assembly, installation, development or abandonment if the contaminant concentrations or geologic setting require alternative construction. Prior written approval is required before any alternative materials are used in monitoring well installation.

(2) Exceptions to the requirements of this chapter may be approved by the department prior to installation or abandonment. An exception request shall state the reasons why compliance with the rule requirements is infeasible. The department may conditionally approve an exception by

requiring materials or procedures which safeguard against contamination and result in groundwater monitoring well construction which is substantially equivalent to the requirements of this chapter. Failure to comply with the conditions of an exception voids the department's approval of the exception.

History: Cr. Register, January, 1990, No. 409, eff. 2-1-90.

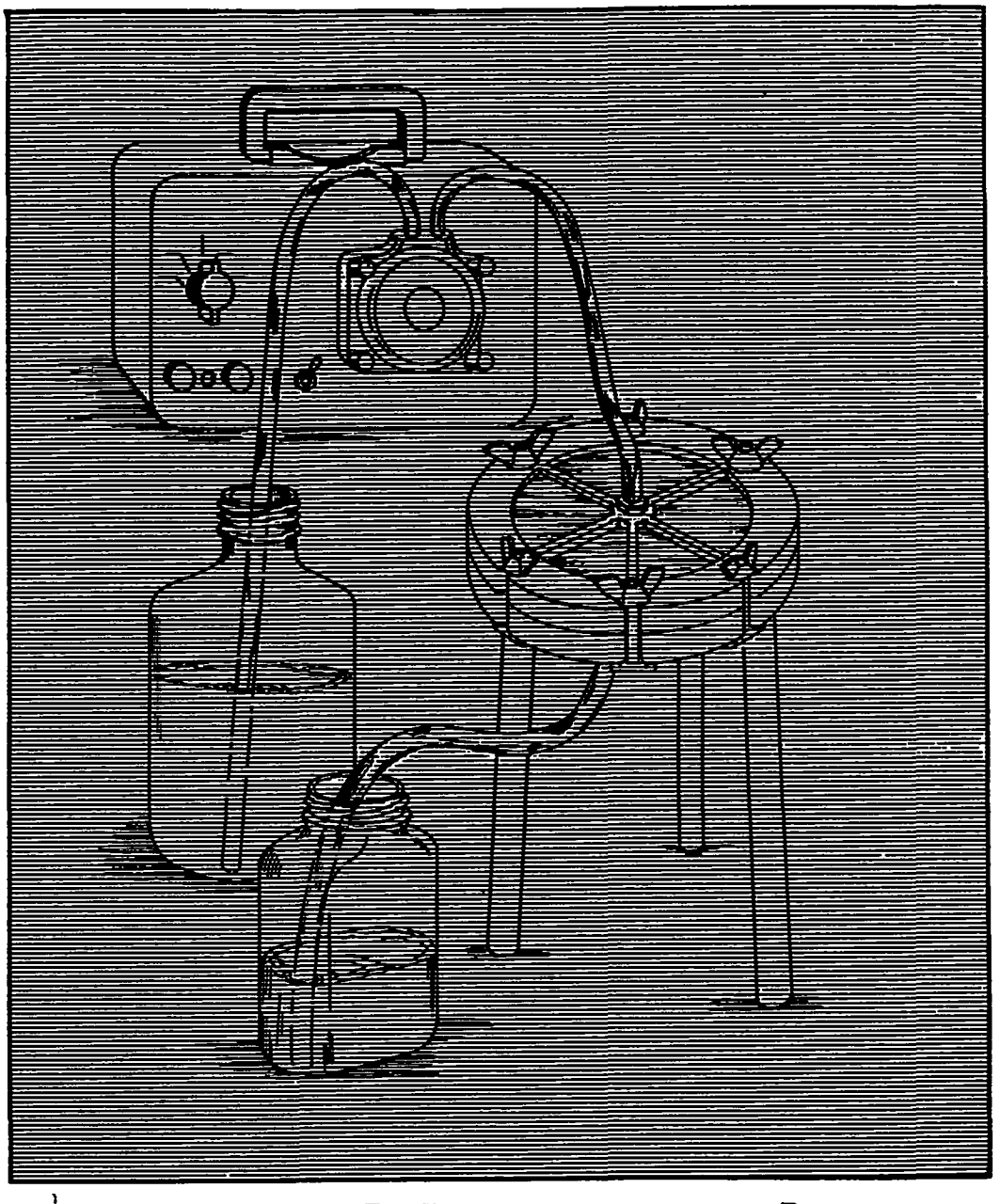
APPENDIX D
DEDICATED SAMPLING SYSTEM OPERATION AND MAINTENANCE MANUALS

TO BE FURNISHED IN FINAL COPY

APPENDIX E
GROUNDWATER SAMPLING PROCEDURES FIELD MANUAL

Wisconsin Department of Natural Resources

Groundwater Sampling Procedures



Field Manual

September 1987

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September, 1987

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IN REPLY REFER TO: 3230

Open Letter to DNR Staff, Regulated Facilities, Consulting Firms, Laboratories and Interested Individuals:

SUBJECT: Groundwater Sampling Field Manual

This Field Manual has been developed by the Wisconsin Department of Natural Resources (DNR) to promote uniform groundwater sampling procedures in the field. We intend it to be used by DNR staff and others responsible for groundwater monitoring. This manual is an abbreviated version of the Department's "Groundwater Sampling Procedures Guidelines," published in February, 1987. The Guidelines contain detailed explanations and technical justifications for instructions listed in this manual. We strongly recommend that you read the "Groundwater Sampling Procedures Guidelines" before using this field manual. You may also want to refer to the Department's "Field Procedures Manual for Water Quality and Compliance Monitoring" for additional sampling information.

Use this manual to prepare for sampling, to assist you while sampling and to document the procedures you follow while sampling in the field. Use the blue pages when sampling monitoring wells and the yellow pages when sampling water supply wells.

We hope that this document will help ensure the collection of consistent and reliable groundwater quality data. We invite comments from all who use the Field Manual on ways it can be improved. We intend to review the Field Manual periodically and revise it as appropriate.

If you have any questions regarding the Field Manual, please call Jodi Feld of the Bureau of Solid Waste Management at (608) 266-0941 or Dave Lindorff of the Bureau of Water Resources Management at (608) 266-9265. Written comments are welcome and should be directed to either of these two individuals at the above address.

Sincerely,

Lyman F. Wible

Lyman F. Wible, Administrator
Division of Environmental Standards

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TABLE OF CONTENTS

SAMPLING PROCEDURES FOR MONITORING WELLS

A. PRE-SAMPLING CHECKLIST

Equipment (Not all of the following may be necessary each time you sample.):

____ 1. A map of the site (preferably a 8-1/2" x 11" topographic map) that shows the access roads and the locations of the wells you will be sampling.
____ 2. A field notebook and Well Specific Field Sheet (WSFS) forms for recording all observations.
____ 3. Well Information Forms (WIF's), well construction reports or well logs for all wells being sampled.
____ 4. Waterproof marking pens or pencils.
____ 5. Calculator and necessary conversions (or tables) to calculate the volume of water you will need to purge from the well(s).
____ 6. Keys for all locked well caps.
____ 7. Camera and film.
____ 8. Water level measuring device and a backup (make sure it will extend deep enough to reach water in the well). If using an electrical tape, bring extra batteries.
____ 9. Sampling and purging device (make sure the diameter is compatible with the well diameters being sampled).
____ 10. Plastic bags or plastic sheets to place on the ground around the well.
____ 11. Calibrated bucket to measure the volume of water removed when purging the well.
____ 12. Extra rope (if a bailer is being used).
____ 13. Five feet of tubing for peristaltic pump.
____ 14. Transfer containers.
____ 15. Sample containers (should be provided by the lab); bring extra for field quality control (blanks, duplicates) and to allow for breakage.
____ 16. Labels for sample containers and preservatives*. Bring extra.
____ 17. Thermometer.
____ 18. Conductivity meter, standards, and extra batteries.
____ 19. pH meter, buffers, extra batteries, beakers for buffers and standards.
____ 20. Filtering apparatus (make sure all of the parts are included), filter membranes (0.45 micron pore size) and pre-filters.
____ 21. Preservatives (should be provided by the lab; bring extras)*.
____ 22. pH paper*.
____ 23. Lab sheets (if required by your lab).
____ 24. Ice or frozen cold packs to cool the samples.
____ 25. Cooler large enough to hold all the sample containers (including duplicates and blanks) and ice.
____ 26. Lab packs for the samples that need to be mailed to the lab.
____ 27. Tape and stamps for mailing.
____ 28. At least two 250 ml bottles with squirter (for rinsing).
____ 29. Scrub brush for cleaning sampling equipment.
____ 30. Two five gallon jugs of reagent grade water from your lab. Note: Do not purchase this water from a supermarket.
____ 31. Tools: wrenches, screwdrivers, hammers, scissors/utility knife.
____ 32. Miscellaneous hardware: nails, screws, washers, etc.
____ 33. Plastic gloves, face shields, respiratory equipment, if needed.
____ 34. First aid kit.
____ 35. Treble fish hook with sinker to retrieve bailer.

*Contained in State Lab of Hygiene Preservation Kit.

Procedures:

____ 1. Contact the lab coordinator with sampling information (date, number of samples, analyses desired). DNR only.
____ 2. Check equipment log book for previous problems with equipment.
____ 3. Check equipment for good working order.

____ test batteries
____ test with a tap sample
____ calibrate instruments

____ 4. Follow the formalized procedures set up by your company/agency to check out equipment for use.
____ 5. Check diameter of sampling equipment for compatibility with wells to be sampled.
____ 6 Measure volume of water your bailer holds if not done previously.
____ 7. Fill in as much of the data collection sheets as possible (i.e., lab sheets and well inventory forms).
____ 8. Obtains keys to the wells.
____ 9. Familiarize yourself with chain of custody procedures.
____ 10. Review general site hydrogeology and past water quality information (i.e., Turn Around Documents). List wells from least to most contaminated.
____ 11. Review well information:

____ Well location
____ Well depth
____ Well diameter
____ Well casing elevation (top of casing)
____ Well screen elevation (and depth to top of well screen)
____ Well screen length
____ Well history (ex: recovery times)
____ Water level depth

____ 12. Assign a sample point ID for all wells without a sample point ID.

____ 13. Locate the nearest post office or United Parcel Service office if you'll need to mail samples to the lab.

B. MEASURING WATER LEVEL

Use the following procedures to measure static water levels with a popper:

1. Rinse the popper and line with reagent grade water.

2. Lower the popper into the well.

3. Listen for the "pop." You may have to raise and lower the popper several times to make sure you have found the water level.

4. Read the tape measurement at the prescribed reference point (generally a specific point at the top of the inner casing) to the nearest .01 foot and add the length of popper to arrive at the depth to water.

5. Subtract the depth to water from the reference point elevation to yield the water level elevation. If the elevation at the top of the well is not known, survey the well to a benchmark or reference point with a known elevation.

6. Use the popper to determine the depth of the well.

Use the following procedures to measure static water levels using a coated tape:

1. Lower the tape into the well until you hear or feel the tape reach the water surface. Lower the tape a few inches into the water.

2. Read the tape measurement at the top of the casing to the nearest .01 feet.

3. Withdraw the tape from the well and record the measurement where the wetted and dry portions of the tape meet.

4. Subtract this value from the elevation of the top of the casing. This difference is the depth to the water surface.

5. Subtract the depth to water from the elevation at the top of the casing to yield water level elevation. If the elevation at the top of the well is not known, survey the well to a benchmark or reference point with a known elevation.

6. Use the tape to determine the depth of the well.

Use the following procedures to measure static water levels with an electric tape:

1. Lower the probe or electrode into the well by pulling cable from the hand held reel.

2. Continue lowering until the bulb lights up, the beeper beeps or the ammeter needle deflects, indicating that the water table has been reached.

3. Measure the length of cable in the well from the top of casing or other monitoring point to the probe (depth to the water table) and subtract from the measuring point elevation to determine the water level elevation.

C. PURGING

Wells Screened in Low Permeability Formations (Wells that can be purged dry):

1. Pump (or bail) the well dry.
2. Allow the well to recover after purging.
3. Purge the well a second time, if time permits.
4. Collect the sample as soon as there is a sufficient volume of water for the intended analyses (not necessarily when the well is fully recovered).

Wells Screened in High Permeability Formations:

1. Remove four well volumes (calculate as shown in equation (1) or refer to Table 1).
2. Purge wells by pumping or bailing from as near the water surface as possible to ensure that no stagnant water remains in the well above the screen after purging.
3. Introduce as little air and turbulence into the formation as possible to prevent alteration of the samples.

EQUATION (1)

$$V = \left[\pi \bullet \left(\frac{D}{2}\right)^2 \bullet H\right] \times 4 \times 7.48$$

Where:

V = Total volume of water needed to purge (gallons)
D = Inside diameter of well (ft)
H = Height of water column in well (ft)
(depth to bottom of well minus depth to water)

TABLE 1: Volume of Water Contained in One Foot Section of Well Casing

Inside Diameter (inches)	Volume of Water (Gallons)	Gallons to be Purged (4 x Vol. of Water)
1	0.041	.163
1 1/4	0.064	.255
1 1/2	0.092	.367
2	0.163	.652
3	0.367	1.469
4	0.653	2.610

D. WITHDRAWING SAMPLES

Before Sampling:

1. Choose a sampling device which minimizes the potential for altering the water quality of the sample.

2. Withdraw samples shortly after purging (as soon as a volume of water sufficient for the intended analyses reenters the well).

3. Sample the least contaminated wells first, the more contaminated wells last (i.e., sample in increasing order of contamination). If the degree of contamination is unknown, sample the upgradient wells first, the downgradient wells last.

4. Withdraw samples from within or just above the screened section of the well.

Sampling With A Bailer:

Note: The Department strongly recommends the use of bottom emptying devices when sampling with a bailer.

1. Rinse the bailer and line with reagent grade water.

2. Place a large clean plastic bag or cloth on the ground around the well to prevent the bailer rope from touching the ground.

3. Lower the bailer slowly and gently into contact with the water in the well. Do not simply let the bailer fall free into the well while holding the end of the rope. Do not allow the bailer to touch the bottom of the well.

4. Lower the bailer to the same depth in the well each time, preferably within or just above the screened interval.

5. Retrieve the bailer smoothly (do not allow the bailer rope to touch the ground). If the bailer is not retrofitted with an in-line filtering system, empty the water in a slow steady stream in the following order:

   a) Slowly pour an unfiltered portion into a sample container for the required in-field analyses (one person should perform the in-field analyses immediately while the other continues collecting samples for other analyses).

   b) Slowly pour an unfiltered portion into sample containers for volatile organics analyses (as necessary). Collect samples for VOC's from a bailer-full of water as soon as it is brought to the surface. Refer to the next page for special procedures to be followed when sampling for VOC's.

c) Slowly pour a portion into the sample containers for all other unfiltered analyses (as necessary). Preserve and cap quickly.

d) Slowly pour a portion of the sample into a transfer bottle for analyses requiring field filtering. Draw the sample through the filter into the collection bottles. (See Section F for details on field filtering.) Preserve and cap quickly.

6. Rinse the bailer and line with reagent grade water.

Sampling With A Pump:

1. Rinse the pump and associated apparatus with reagent grade water.

2. Position the pump inlet in the well such that water is removed from the same portion of the well each time, preferably within or just above the screened interval.

3. Set the discharge of the pump at a slow rate.

4. Direct the sample into the containers in the same order as with a bailer.

Special Procedures When Sampling for VOC's:

1. Evaluate the area around the sampling point prior to sample collection for possible air contamination by VOC's. Products that may give off VOC's and possibly contaminate a sample include perfumes and cosmetics, skin applied pharmaceuticals, suntan lotion, and automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) Keep the caps off the sample vials for as short a time a possible.

2. Wear clean gloves (latex or surgical) when sampling for VOC's.

3. Use a bottom-emptying device when using a bailer to sample for VOC's.

4. Do not use a suction pump when sampling for VOC's.

5. Keep the VOC sample bottles and the containers used for mailing the bottles tightly sealed to prevent possible contamination.

6. The State Lab of Hygiene (LOH) requires four 40 ml vials with septum tops to be filled by DNR staff. Although the size of the sample bottles may vary, the same procedures should be followed for collecting VOC samples to be submitted to other labs.

7. Remove the cap ring from the sample vial. Make sure that the teflon liner does not fall out. If the liner falls out, replace it in the cap ring and flush the cap with reagent grade water.

8. Fill the sample vial immediately by allowing the water stream to strike the inner wall of the vial to minimize formation of air bubbles. Do not rinse the sample vial before filling. Fill the sample vial, with a minimum of turbulence, until the water forms a positive meniscus at the brim. Allow the vial to overflow slightly.

9. Replace the cap quickly by gently setting it on the water meniscus. Tighten firmly, but do not over tighten. Invert the vial and tap it lightly. If you see air bubbles in the sample, do not add more sample. Empty the vial and use the extra vial to collect another sample. If bubbles form in the sample collected in the extra vial, empty the vial and collect the sample again in the same vial. Do not filter samples collected for VOC analysis.

10. Repeat this procedure for the other vials, opening only one at a time.

E. IN-FIELD MEASUREMENTS

The following are general procedures. Refer to the Department's "Field Procedures Manual for Water Quality and Compliance Monitoring" or your own sampling plan for more detailed instructions.

Temperature:

1. Rinse the thermometer with reagent grade water.

2. Immerse the thermometer in a freshly collected sample.

3. Wait for the temperature to equilibrate (no more than 2-3 minutes).

4. Read and record the temperature to the nearest 1.0°C while the thermometer is immersed in the sample (do not pull the thermometer out of the sample.)

5. Rinse the thermometer with reagent grade water, and place it somewhere safe for future use.

Specific Conductance:

1. Set up and calibrate the conductivity meter according to the manufacturer's instructions.

2. Set the dial to the desired range for measurement (ex: x100 umhos/cm range).

3. Measure the temperature of the sample with a thermometer and set the temperature dial on the conductivity meter to the measured temperature (if required by your particular meter).

4. Rinse the probe (and thermometer if one is used) with reagent grade water.

5. Place the probe in the sample and move it up and down several times. Rotate the cell slowly in the sample until the reading stabilizes. (Some cells may require different procedures.)

6. Read and record the conductivity measurement and the temperature. Multiply the reading by the range to which the dial is set.

7. Rinse the probe with reagent grade water.

8. Correct the measurement to 25°C using the equation supplied by the manufacturer (if not already corrected by the meter).

pH:

1. Set up and calibrate the pH meter according to the manufacturer's instructions to cover the range of expected values. The temperature of the buffers and the sample should be within 5°C of each other.

2. Rinse the electrodes thoroughly with reagent grade water.

3. Immerse the electrode in the sample.

4. Wait for the reading to stabilize (usually no more than 2 or 3 minutes).

5. Read and record the pH to the nearest 0.1 unit.

6 Remove the electrode from the sample.

7. Rinse the electrode with reagent grade water.

8. Store the electrode in the buffer solution (or solution recommended by the manufacturer) between sample measurements.

9. Recalibrate every 5 samples.

Color, Odor, and Turbidity:

Color: Note color after filtration against a white background.

Odor: Carefully wave your hand over the opening of the sample container and note any distinct smell. Do not smell the sample directly, particularly when dealing with hazardous or unknown materials.

Turbidity: Comment on turbidity, e.g. cloudy, turbid, clear.

F. FIELD FILTERING

Inorganic Compounds:

1. Set up the filtering apparatus.

2. Place a 0.45 micron membrane filter on the apparatus (using tweezers). If the sample contains a lot of sediment, use a pre-filter to prevent clogging.

3. Flush a minimum of 500 ml of reagent grade water through the filtering apparatus before filtering the sample.

4. Pump the sample through the filter and discard at least 150 ml (if you have enough extra volume).

5. Collect the remaining volume of sample needed in the sample containers.

6. Remove the filter membrane (and the pre-filter if used) after the sample is collected and discard. DO NOT REUSE FILTER PAPER FOR ANOTHER SAMPLE.

7. Flush the filtering apparatus and tubing with 500 ml reagent grade water.

8. Reassemble the filtering apparatus.

Volatile Organic Compounds:

Do not filter samples collected for VOC analysis.

G. SAMPLE PRESERVATION

Preservation Techniques:

Preserve samples immediately after sampling (and filtering, if required) according to your lab requirements. See Attachment B for preservatives required by the State Lab of Hygiene for DNR staff.

Use of pH Paper:

Follow these procedures to test the pH of a sample after preserving with acid:

1. Tip sample container gently on its side so that some sample wets the container lid.
2. Remove the sample container lid.
3. Touch the pH paper to droplets on the lid. (DO NOT put the pH paper directly into the bottle of collected sample water.)
4. Read the pH.
5. Adjust pH of preserved sample, and repeat steps 1-4 if necessary.
6. Rinse the lid with sample before capping.

H. MAILING SAMPLES

1. Complete a lab form and record all pertinent information.

2. If samples are to be mailed, seal the mailer securely with strapping tape. Samples must be kept cold and unfrozen at all times. Resampling may be necessary if samples are received warm by the laboratory. To assure that samples stay cold in transit, use the following procedures:

   a) Freeze freezer packs solidly prior to use
   b) Use coolers to transport the sample cases and frozen packs in the field, whenever possible
   c) Place a fresh frozen pack in each mailer just prior to mailing

3. Ship immediately to a certified laboratory using Parcel Post Special Handling or United Parcel Service, whichever is faster in your area. Contact the DNR Central Office, Bureau of Technical Services, for information on certified laboratories.

I. QUALITY CONTROL/QUALITY ASSURANCE

Sample from the least contaminated to the most contaminated well.

Field Blanks:

1. Collect the field blanks when sampling downgradient wells.

2. Collect a minimum of one field blank per sampling event or one every 10 samples, whichever is greater.

Trip Blanks:

Include a trip blank in each sample shipper used to collect VOC samples.

Field Duplicates:

Collect field duplicates at a frequency appropriate for the project (based upon the results of previous sampling). DNR staff are required to take one duplicate per sampling event.

Split Samples:

1. Sample the well, filter the sample (if required) and collect the sample in two containers for separate analysis.

2. Preserve the sample according to the instructions from your laboratory.

3. Fill one bottle completely from each set until all bottles are filled when collecting split samples for VOC analysis.

Cleaning Sampling Equipment:

1. Check with your laboratory for recommended cleaning procedures.

2. Rinse the sampling equipment (and water level measuring device) three times with reagent grade water after obtaining a groundwater sample from the monitoring well.

3. Clean sampling equipment between sampling trips with a non-phosphate detergent, rinse three times with tap water, then rinse three times with reagent grade water.

4. Take special care when rinsing after a detergent wash to make sure all the detergent is removed.

Chain of Custody:

Follow the procedures specified by your laboratory for handling chain of custody samples.
DNR staff: Follow the procedures in Attachment C. Also check the Department's "Field Procedures Manual" for any changes in chain-of-custody procedures.

J. DOCUMENTATION

1. Use the Well Specific Field Sheet (Attachment A) for monitoring wells for each well sampled in the field.

2. Check to see if the facility being sampled has a sampling plan approved by and on record with the Department.

3. Require preparation of a sampling plan for those facilities without one.

K. TROUBLESHOOTING

Below is a list of commonly occurring problems and possible remedies.

Problem: Conductivity meter unresponsive, erratic or sluggish.

Solution:

a) Check batteries and replace, if necessary.

b) Check that cell is completely immersed and is not touching bottom or sides of container. Trapped air can depress the conductivity reading. Immersion must be at least 1/2" above the uppermost air vent and sample must be free of air bubbles.

c) Check that electrodes are clean. Chemical cleaning may be necessary.

d) Check for obstructions in cell and remove if necessary.

e) Check that probe jack is dry. A wet probe jack can cause an unstable response.

Problem: Sample not coming through filter adequately.

Solution:

a) Filter paper may be clogged--change if necessary. If sample is very turbid, use a pre-filter.

b) Check that pumping rate is sufficient to pull sample through filter.

c) Reverse flow direction for a few seconds.

d) Tighten nuts on filter to prevent leakage.

e) Check for holes in tubing.

Problem: Bailer lost in well (line becomes detached).

Solution: Try using a fishing line and hook or hanger to retrieve the bailer.

Problem: Lock on well cap is frozen.

Solution: Try using a lighter or match to heat the lock. Try blowing on the lock.

ATTACHMENT A

Well Specific Field Sheet (WSFS) - Monitoring Wells

Fill out one column of this form for each monitoring well which is sampled on each sampling date.

Facility Name: _____ Date: _____

License or Permit #_____ Weather Conditions: _____

Persons Sampling: _____

Sampling Equipment (for measuring water level, purging, sampling and filtering. Include model if appropriate.) _____

*Well Name					
*DNR I.D. No.					
*Pipe top elevation (MSL) Reference elevation if different					
Measured depth to water (ft)					
Correction					
Total depth to water (ft)					
**Water elevation (MSL)					
Depth to bottom of well (ft)					
Volume H_2O in well (gal)					
Volume to be purged (4x vol. in well)					
Time purging begun					
Time purging completed					
Purged dry? (Y/N)					
Time sample withdrawn					
Field temperature (°C)					
Field conductivity (uncorrected)					
**Field conductivity (at 25°C)					
Time conductivity measured					
Field pH (std. units)					

Time pH measured					
Color (Y/N)					
Odor (Y/N)					
Turbidity (Y/N)					
Sample field filtered? (Y/N)					
Time filtered					
Well cap and lock replaced? (Y/N)					

Comments (discuss condition of well, casing, seal, etc. and problems, including any deviations from the sampling plan):

* Fill out before going into field
** Can be calculated later

ATTACHMENT B

Bottle Types, Sample Volumes and Preservation Requirements

Parameter	Required Bottle Type (mL)	Volume Required (mL)	Preservative[1]	Volume c Preservati Required[2]
Alkalinity	625	50	Cool, 4°C	—
Alkalinity-Gran Technique[3]	125	100	Cool, 4°C	—
Biochemical Oxygen Demand, 5 Day	625	100	Cool, 4°C	—
Biochemical Oxygen Demand, Long Term[4]	Quart	2200[5]	Cool, 4°C	—
Boron	60	25	Cool, 4°C	—
Chemical Oxygen Demand	250	50	H_2SO_4 to pH<2, Cool, 4°C	2 mL 12.5% H_2SO_4/250 m
Chloride	625	25	none required	—
Chloride, I.C.[6]	60	5	Cool, 4°C	—
Chlorophyll a	Quart	1000-3000*	Cool, 4°C, keep in dark	—
Color	625	50	Cool, 4°C	—
Corrosivity	Quart	1000	none required	—
Cyanide[7,8], Total	Quart	1000*	NaOH to pH>12, Cool, 4°C	about 5 NaOH pellets/quart
Cyanide[7,8], Amenable to Chlorination	Quart	1000	NaOH to pH>12, Cool, 4°C	about 5 NaOH pellets/quart
Fluoride	625,60	25	none required	—
Metals, Ag, Al, As, Ba, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Se, Sn, Zn, Hardness (all metals except Hg, Cr^{+6})	250 Metals	250*	HNO_3 to pH<2	2.5 mL 35% HNO_3 to pH<
Hexavalent Chromium	250 Metals	50	Cool, 4°C	—
Mercury	250 Metals	250*	HNO_3 to pH<2	2.5 mL, 35% (8N) HNO_3
Nitrogen, Ammonia	250	25	H_2SO_4 to pH<2, Cool, 4°C	2 mL, 12.5% (4.5N) H_2 250 mL
Nitrogen, Nitrate plus Nitrite	250	25	H_2SO_4 to pH<2, Cool, 4°C	2 mL, 12.5% (4.5N) H_2 250 mL
Nitrogen, Nitrate, I.C.[6]	60	5	Cool, 4°C	—

Parameter	Required Bottle Type (mL)	Volume Required (mL)	Preservative[1]	Volume of Preservative Required[2]
Nitrogen, Nitrate plus Nitrite (Drinking waters Only)	60	25	None required	-
Nitrogen, Total Kjeldahl	250	25	H_2SO_4 to pH<2, Cool, 4°C	2 mL 12.5% (4.5N) H_2SO_4 250 mL
Oil and Grease	Quart Glass Mason	1000*	H_2SO_4 to pH<2, Cool, 4°C	4 mL (2 ampu 12.5% (4.5N) H_2SO_4/Quart
pH (Determine on site)	625	25	Determine on site Lab pH for reference only	—
Phenol	Quart Glass Mason	1000*	H_2SO_4 to pH<2, Cool, 4°C	4 mL (2 ampu 12.5% (4.5N) H_2SO_4/Quart
Phosphorus, Dissolved (For special studies, may be filtered on site)	60	25	Cool, 4°C	—
Phosphorus, Total	250	25	H_2SO_4 to pH<2,	2 mL, 12.5% (4.5N) H_2SO_4 250 mL
Reactivity - explosives	30	0.01 grams	—	—
Residue, Dissolved (Filterable)	625	50	Cool, 4°C	—
Residue, Total and Total Volatile	625	50	Cool, 4°C	—
Residue, Suspended (Nonfilterable), and Volatile Suspended	625	200	Cool, 4°C	—
Silica, Dissolved	625, 60	25	Cool, 4°C	—
Specific Conductance	625	50	Cool, 4°C	—
Sulfate	625	25	Cool, 4°C	—
Sulfate, I.C.[6]	60	5	Cool, 4°C	—
Sulfide	625	625*	Add zinc acetate, minimize air contact, Cool, 4°C	18 drops 2N zi acetate/625 m
Sulfite	625	625*	Add EDTA, minimize air contact, Cool, 4°C	6 mL EDTA solution/625 m
Surfactants (MBAS)	625	250	Cool, 4°C	—

Parameter	Required Bottle Type (mL)	Volume Required (mL)	Preservative[1]	Volume Preservat... Required[2]
Toxic Extraction Procedure	Quart Glass Mason	Call Lab[9]	—	Do Not Preserve
Turbidity	625	25	Cool, 4°C	—

* Volume includes Quality Control effort.

1 Sample preservation should be performed immediately upon sample collection. DO NOT ... chemical preservatives to solid and hazardous waste samples. Composite samples that requ... multiple preservations should be preserved only by maintenance at 4°C until the compositing an... sample splitting are completed.

2 This is the volume of preservative generally found to be sufficient to achieve the proper pH... However, additional preservative may be required in highly buffered samples. The final pH ... preserved samples should be verified with pH paper.

3 This test is only performed after approval by the DNR Lab coordinator. Special 125 mL bottles ar... available from the Laboratory. Contact the Lab for instructions.

4 Most Long Term BOD samples require seeding. Submit a 250 mL plain bacteria bottle of recei... surface water, collected down stream from the discharge, for the seed material.

5 The Long Term BOD volume requirement depends on the expected BOD_5.
For example, samples with an expected BOD_5 of <20 mg/L require 2200 mL of sample to set ... long term BOD test, while those with an expected BOD_5 between 20-50 mg/L require 1000 mL, an... with an expected BOD_5 of >50 mg/L require 500 mL.

6 Ion chromatography (IC) analysis only. Special arrangements must be made through the DNR ... coordinator before the analyses can be performed by the Lab.

7 Cyanide samples containing residual chlorine should be treated with 0.6g ascorbic acid/L of sam... at the time of collection. The sample collector should make arrangements with the lab to obtain ... ascorbic acid.

8 Sulfide will interfere with the cyanide test and must be removed before the pH is adjusted. I... sulfide is present, contact the lab for special instructions before collecting the sample.

9 A minimum of 100 g sample is required to perform the analysis. Call the laboratory to confirm ... sample size necessary for quality control checks.

ATTACHMENT C

Chain of Custody for Enforcement Samples

To be admissible as evidence, sample results must be traceable back through their collection, shipment and analysis so that the court is satisfied how the sample results submitted as evidence were collected, transferred and claimed. This is accomplished by a written record which documents the sample identity from collection to introduction as evidence.

Field records which identify sampling personnel, sampling techniques and field conditions are required. The field investigator is responsible for maintaining sample custody until the State Laboratory of Hygiene (SLOH) accepts the sample in person.

A sample is in custody if it is:

1. In physical possession, or

2. In view, after being in physical possession, or

3. Locked up so that no one can tamper with it.

Two degrees of chain of custody have been accepted by the courts. The first, described above, involves physical possession of the sample from collection to lab possession. With this method, the investigator personally delivers the sample to the lab and picks it up. The second is by sample shipment through mail carriers.

In both cases, a written record must be transferred with the samples. However, in the second method, the collector fills out the chain of custody record, seals it in a shipping container, and ships it by U.S. mail to the SLOH. Upon arrival, a pre-determined (from prior laboratory scheduling) laboratory custodian collects the sample, notes its condition (whether sealed or unsealed) and maintains lab chain of custody records.

For routine surveillance samples, the second method of sample chain of custody should suffice. If enforcement action is likely to occur based on the samples, the first method of physical possession is recommended.

A. Field Chain of Custody Procedures

   1. Limit sample handling to as few people as possible. If transfers are necessary, signed receipts should be used. (The attached Chain of Custody Record form should accompany the sample.) The sampler should keep a copy for his/her own records.

   2. If sample is suspected to be hazardous, a receipt for each sample collected shall be given to the property or facility owner (s. 144.69, Wis. Stats.) The owner may request a split sample.

   3. Follow Handling and Preservation Handbook and Quality Assurance Handbook for sampling procedures.

4. Record field measurements and other important data in a bound field book.

5. Complete appropriate lab slip and attach to chain of custody record.

6. When necessary, document sample locations, pollution sources, violations, etc., with photographs.

7. Maintain physical possession of collected samples until properly transferred to the SLOH sample custodian.

8. Obtain a sample receipt from the SLOH custodian on transfer of samples to the lab.

B. Packing Enforcement Samples

This is the procedure which must be followed in packing enforcement samples in order to maintain the chain of custody.

1. Tape the field pack shut using nylon-reinforced tape. The ends should be straight and should be overlapped slightly.

2. Using a waterproof pen, write the following information on the tape, and over the overlapping ends.

   a. Name of person taking sample, date, time and water body, facility, etc., where the sample was taken.

   b. The words "ENFORCEMENT CASE."

   c. The words "To be opened by _____ personnel only." In the blank specify water chemistry unit, air chemistry unit, pesticides and organic chemistry unit, or water microbiology unit, as appropriate.

   d. If all the samples are organic, specify "organic". If they are all inorganic, specify "inorganic".

   By overlapping the edges of the tape and writing over them you'll be able to tell whether someone has tampered with the field pack. If the tape has been removed, it will be difficult to get the writing correctly lined up when the tape is put back on.

   Do not use sealing wax to seal the tape. Sealing wax is brittle and will chip and break during normal use. This gives the appearance of tampering even when none has taken place.

Field packs which are labeled ENFORCEMENT CASE are locked up by the State Lab as soon as they arrive and are not taken out until they are analyzed. When they are taken out, a red "ENF" is stamped on the sample bottle and on the corresponding lab slip. A number is placed on the bottle which corresponds to the number on the lab slip. Enforcement samples are kept in sight at all times when they are being worked on, and are locked up again as soon as the work is done.

The lab will keep all enforcement samples until notified that the samples are no longer needed. When an enforcement case is resolved, either by stipulation or trial, the enforcement specialist should notify the lab that the samples connected with that case may be discarded.

State of Wisconsin
Department of Natural Resources

CHAIN OF CUSTODY RECORD
Form 4100-145 7-87

Sample Collector(s)	Title/Work Station	Telephone No. (include area code)
Property Owner	Property Address	Telephone No. (include area code)

Split Samples: Offered? ☐ Yes ☐ No (Check One)
Accepted? ☐ Yes ☐ No (Check One) Accepted By: _____
Signature

Sample ID No.	Date	Time	Sample Type		Station Location Sample Description	Lab ID Number	No. of Containers	Comments
			Comp	Grab				

I hereby certify that I received, properly handled, and disposed of these samples as noted below:

Relinquished By (Signature)	Date/Time	Received by: (Signature)
Relinquished By (Signature)	Date/Time	Received by: (Signature)
Relinquished By (Signature)	Date/Time	Received for Laboratory By: (Signature)

Disposition of Unused Portion of Sample:

Dispose _____ Retain for _____ days

Return _____ Other _____

SAMPLING PROCEDURES FOR WATER SUPPLY WELLS

A. PRE-SAMPLING CHECKLIST

Equipment (Not all of the following may be necessary each time you sample.):

____ 1. The addresses and directions to the homes at which you will be sampling.
____ 2. A field notebook for recording all observations.
____ 3. Waterproof marking pens or pencils.
____ 4. Special tap connection and tube to collect sample from taps which are not readily accessible.
____ 5. Bucket to collect the water removed when purging the well or spilled when sampling.
____ 6. Sample containers (should be provided by the lab); bring extra for field quality control (blanks, duplicates) and to allow for breakage.
____ 7. Labels for sample containers and preservatives*.
____ 8. Thermometer.
____ 9. Conductivity meter, standards, and extra batteries.
____ 10. pH meter, buffers and extra batteries.
____ 11. Preservatives (should be provided by the lab; bring extras)*.
____ 12. pH paper*.
____ 13. Lab sheets (if required by your lab).
____ 14. Inventory sheets or field data sheets (DNR use only).
____ 15. Ice or frozen cold packs to cool the samples.
____ 16. Cooler large enough to hold all the sample containers.
____ 17. Lab packs for the samples that need to be mailed to the lab after sampling.
____ 18. At least two 250 ml squeeze bottles (for reagent grade rinsing).
____ 19. Two five-gallon jugs of reagent grade water (amount depends on number of wells to be sampled) from your lab. Note: Do not purchase this water from a supermarket.
____ 20. Tape and stamps for mailing.

Procedures:

____ 1. Contact well owner to confirm sampling date.
____ 2. Determine if well has been inventoried. If not, obtain DNR inventory number.
____ 3. Locate well construction report for each well to be sampled.
____ 4. Contact the lab with sampling information (date, number of samples, analyses desired).
____ 5. Check equipment log book for previous problems with equipment.
____ 6. Check equipment for good working order.

____ test batteries
____ test with a tap sample

*Contained in State Lab of Hygiene Preservation Kit

_____ 7. Follow the formalized procedures set up by your company/agency to check out equipment for use.

_____ 8. Fill in as much of the data collection sheets as possible (i.e., lab sheets and inventory form).

_____ 9. Familiarize yourself with chain of custody procedures.

_____ 10. Review past water quality information.

_____ 11. If sampled previously, review previous field log to determine the following information:

_____ Location of tap from which to take sample
_____ Need for special tap connection and tube
_____ Problems encountered at specific location in past

_____ 12. Locate the nearest post office or United Parcel Service office if you'll need to mail samples to the lab.

B. MEASURING WATER LEVEL, WELL DEPTH AND CASING DEPTH

Measure the water level, well depth and/or casing depth with the assistance of someone who has experience using the proper procedures. In most cases, it will be necessary to remove the pump before attempting these measurements, except for water level measurements. Use extreme care so as not to damage or contaminate the well.

Initial Procedures:

1. Call the well owner the night before you plan to measure the water level and ask him/her to use a minimal amount of water in the morning prior to your arrival.

2. Inform the well owner of the procedures you will follow when measuring water levels, well casing depth or total well depth. Ask the owner if it is alright to add chlorine to the well for disinfection purposes after the measurements have been taken. Tell the owner which disinfection method will be used. If the owner rejects chlorination, do not take measurements in their well, except if absolutely necessary.

3. Collect a water sample for coliform bacteria analysis using proper sample collection procedures. It is recommended that the sample be collected from the well sample tap or the tap nearest the well. Send the sample to the State Laboratory of Hygiene for analysis.

4. Ask the owner to turn off the pump for safety and to avoid the pump starting, especially if water level measurements are being taken.

5. Disinfect any equipment before it is put into the well to prevent the introduction of coliform or iron bacteria into the well. Rinse all parts of any equipment to go into a well with a dilute chlorine solution (2 capfuls of liquid chlorine bleach in 1 gallon of water). A clean cloth or paper towels soaked in dilute chlorine solution would also be acceptable to sterilize the equipment. Lay any equipment on a clean cloth or piece of plastic if necessary to lay it down.

Measuring Water Level:

Take a series of water level measurements to determine whether the well is still recovering. If you obtain three consecutive readings separated by a one-minute interval that are within .01 foot, then use this value as your reading. For water level measurements taken to determine groundwater elevations, mark the side of the casing where the water levels are measured to provide a marking point for the survey instrument.

Measuring Total Well Depth:

1. Measure total well depth with a weighted tape or weighted synthetic cord which has been calibrated in tenths of feet. If a cord is used, it must not stretch under tension.

2. Lower the tape or cord until it stops and record the length to the top of the casing.

3. Record the depth to the nearest .1 foot.

Measuring Casing Depth:

1. Use a weighted magnet system which clings to the casing to determine depths of steel casing.

2. Lower the magnet by a marked cable along the casing until the magnet slips off the end.

3. Measure and record the length to the top of the casing.

4. Repeat the process until close valued readings are obtained to avoid accidental error.

Disinfection:

Properly disinfect the well after any measurements are taken.

1. Water Levels

   a) Pour 1/2 to 1 cup of liquid chlorine bleach or 3 to 5 HTH tablets into the well for each 20 feet of standing water in a 6 inch well.

   b) Inform the well owner that a chlorine taste may be present in their water supply system. Instruct them to open their taps until the chlorine taste and odor disappear.

2. Total Well Depth

   a) Disinfect the entire well if total well depth was measured. Add enough solution to displace the amount of water in the well. One-half to one cup of liquid chlorine bleach mixed with 30 gallons of water provides a 50 ppm chlorine solution to displace 20 feet of standing water in a 6 inch well. Mix the solution in a clean container and pour down the well as continuously as possible.

   b) Activate the pump and open the water faucets until a chlorine odor is detected at the faucets. Rinse the side of the casing with the chlorine solution for about 30 minutes.

   c) Tell the well owner to allow the chlorine to stand in the well and distribution system for 24 hours or overnight. Then the faucets should be run until the chlorine odor and taste are no longer detectable.

3. Drive Points

   a) If it is necessary to measure levels in a driven point well, hire a registered pump installer to disconnect the piping.

b) Disinfect according to the procedures described above for Total Well Depth.

4. Casing Depth

   The disinfection method used will depend on how far the magnet is lowered below the water level. Use professional judgment.

5. Post Testing

   Collect a water sample within 3 days from the same tap that the first sample was collected from for coliform bacteria analysis. It may be necessary to use a thiosulfate sample bottle because there may be a chlorine residual in the well. The well owner, if properly instructed, DNR or local health staff may take the sample.

C. PURGING

Large Water Supplies (i.e., Public Water Supplies with Distribution Systems):

1. Take sample at tap near the pump and before storage or pressure systems.

2. Make sure the pump is running and the water is flowing for at least one minute prior to sample collection.

Small Water Supplies (i.e., Private Water Supplies):

1. Take sample as close to the pump as possible and before the water softener, water heater, or pressure tank, if possible. If it is not possible to collect a sample before treatment, note this on the sample sheet. Remove any aerators, filters, or other devices from the tap before taking a sample. If the sample must be taken from an outside tap, remove any hoses before taking a sample.

2. If the sample is collected on the well side of the pressure tank, make sure the pump is running and allow the water to run from the tap for at least two minutes prior to sample collection.

3. If the sample is collected on the plumbing side of the pressure tank, allow the water to run at least five minutes prior to sample collection to flush out water in the pressure tank and cycle the water pump. For large pressure tanks, calculate the necessary flushing time based on pressure tank volume and flow rate.

   Note: If it is difficult or impossible to flush the plumbing system from the sample tap, use a sink, tub or outside faucet. However, return to the tap closest to the well to take the sample.

D. WITHDRAWING SAMPLES

Procedures for VOC Sampling:

Prior to sample collection for VOC's, check the area around the sampling point for possible air contamination by background VOC's. Collect VOC samples to be submitted to the State Laboratory of Hygiene (LOH) according to the following procedures.

Note to DNR staff: The LOH requires four 40 ml vials with septum tops to be filled. Although the size of the sample bottles may vary, the same procedures should be followed for collecting VOC samples to be submitted to other labs.

1. Make sure you have sufficient sample vials or bottles for each well to be sampled.

2. If the sampling faucet has an aerator, remove it.

3. Run water until cold and for at least one minute.

4. Reduce the water flow to a thin stream to reduce aeration.

5. Remove the cap ring from the sample vial. Make sure that the teflon liner does not fall out. If the liner falls out, replace it in the cap ring and flush the cap with running water for 30 seconds.

6. Fill the sample vial immediately by allowing the water stream to strike the inner wall of the vial to minimize formation of air bubbles. Do not rinse the sample vial before filling. Fill the sample vial, with a minimum of turbulence, until the water forms a positive meniscus at the brim. Allow the vial to overflow slightly.

7. Replace the cap quickly by gently setting it on the water meniscus. Tighten firmly, but do not over tighten. If you see air bubbles in the sample, do not add more sample. Empty the vial and use the extra vial to collect the sample. If bubbles form in the sample collected in the extra vial, empty the vial and collect the sample again.

8. Repeat this procedure for the other vials, opening only one at a time.

Procedures for Pesticide Sampling:

Use the same collection procedures as those for VOCs. Normally, pesticide samples are collected by the DNR in one liter amber glass bottles. Fill a minimum of two bottles per well. An additional bottle is usually required for each additional extraction/analysis method if more than one pesticide is requested. The Sample Handling and Preservation Chapter (Organic Chemistry Unit) of the DNR's "Field Procedures Manual" lists pesticide extraction groups.

Procedures for Sampling for Other Parameters:

Make sure you have the appropriate sample bottles (as required by your lab) for the parameters of interest. Follow any requirements of your laboratory in collecting samples for analysis.

E. IN-FIELD MEASUREMENTS

The following are general procedures. See the Department's "Field Procedures Manual for Water Quality and Compliance Monitoring" or your own sampling plan for more detailed instructions.

Temperature:

1. Rinse the thermometer with reagent grade water.
2. Immerse the thermometer in a freshly collected sample.
3. Wait for the temperature to equilibrate (no more than 2-3 minutes).
4. Read and record the temperature to the nearest 1.0°C while the thermometer is immersed in the sample (do not pull the thermometer out of the sample.)
5. Rinse the thermometer with reagent water, and place it somewhere safe for future use.

Specific Conductance:

1. Set up and calibrate the conductivity meter according to the manufacturer's instructions.
2. Set the dial to the desired range for measurement (ex: x100 umhos/cm range).
3. Measure the temperature of the sample with a thermometer and set the temperature dial on the conductivity meter to the measured temperature (if required by your particular meter).
4. Rinse the probe and thermometer if one is used with reagent grade water.
5. Place the probe in the sample and move it up and down several times. Rotate the cell slowly in the sample until the reading stabilizes. (Some cells may require different procedures.)
6. Read and record the conductivity measurement and the temperature. Multiply the reading by the range the nob is set to.
7. Rinse the probe with reagent grade water.
8. Correct the measurement to 25°C using the equation supplied by the manufacturer (if not already corrected by the meter).

pH:

1. Set up and calibrate the pH meter according to the manufacturer's instructions to cover the range of expected values. The temperature of the buffers and the sample should be within 5°C of each other.

2. Rinse the electrodes thoroughly with reagent grade water.

3. Immerse the electrode in the sample.

4. Wait for the reading to stabilize (usually no more than 2 or 3 minutes).

5. Read and record the pH to the nearest 0.1 unit.

6 Remove the electrode from the sample.

7. Rinse the electrode with reagent grade water.

8. Store the electrode in the buffer solution (or solution recommended by the manufacturer) between sample measurements.

9. Recalibrate every 5 samples.

Color, Odor, and Turbidity:

Color: Note color after filtration against a white background.

Odor: Carefully wave your hand over the opening of the sample container and note any distinct smell. Do not smell the sample directly, particularly when dealing with hazardous or unknown materials.

Turbidity: Comment on turbidity, e.g. cloudy, turbid, clear.

F. FILTERING

Samples taken from water supply wells should not be filtered.

G. SAMPLE PRESERVATION

Preservation Techniques:

Preserve samples immediately after sampling (and filtering, if required) according to your lab requirements. See Attachment B for preservatives required by the State Lab of Hygiene for DNR staff.

Use of pH Paper:

Follow these procedures to test the pH of a sample after preserving with acid:

1. Tip sample container gently on its side so that some sample wets the container lid.
2. Remove the sample container lid.
3. Touch the pH paper to droplets on the lid. (DO NOT put the pH paper directly into the bottle of collected sample water.)
4. Read the pH.
5. Adjust pH of preserved sample, and repeat steps 1-4 if necessary.
6. Rinse the lid with sample before capping.

H. MAILING SAMPLES

1. Complete a lab form and record all pertinent information.

2. If samples are to be mailed, seal the mailer securely with strapping tape. Samples must be kept cold and unfrozen at all times. Resampling may be necessary if samples are received warm by the laboratory. To assure that samples stay cold in transit, use the following procedures:

   a) Freeze freezer packs solidly prior to use.
   b) Use coolers to transport the sample cases and frozen packs in the field, whenever possible.
   c) Place a fresh frozen pack in each mailer just prior to mailing.

3. Ship immediately to a certified laboratory using Parcel Post Special Handling or United Parcel Service, whichever is faster in your area. Contact the DNR Central Office, Bureau of Technical Services, for information on certified laboratories.

I. QUALITY CONTROL/QUALITY ASSURANCE

Sample from the least contaminated to the most contaminated well.

Field Blanks:

1. Collect the field blanks when sampling downgradient wells.

2. Collect a minimum of one field blank per sampling event or one every 10 samples, whichever is greater.

Trip Blanks:

Include a trip blank in each sample shipper used to collect VOC samples.

Field Duplicates:

Collect field duplicates at a frequency appropriate for the project (based upon the results of previous sampling). DNR staff are required to take one duplicate per sampling event.

Split Samples:

1. Sample the well, filter the sample (if required), and collect the sample in two containers for separate analysis.

2. Preserve the sample according to the instructions from your laboratory.

3. Fill one bottle completely from each set until all bottles are filled when collecting split samples for VOC analysis.

Cleaning Sampling Equipment:

1. Check with your laboratory for recommended cleaning procedures.

2. Rinse the sampling equipment (and water level measuring device) three times with reagent grade water after obtaining a groundwater sample from the monitoring well.

3. Clean sampling equipment between sampling trips with a non-phosphate detergent, rinse three times with tap water, then rinse three times with reagent grade water.

4. Take special care when rinsing after a detergent wash to make sure all the detergent is removed.

Chain of Custody:

Follow the procedures specified by your laboratory for handling chain of custody samples.
DNR staff: Follow the procedures in Attachment C. Also check the Department's "Field Procedures Manual" for any changes in chain-of-custody procedures.

J. DOCUMENTATION

1. Fill out a Groundwater Monitoring Inventory Form (see Attachment D) if a well has not been previously monitored, so information about the well can be entered into the Department's computerized data base.

2. Verify the ownership and locational information of wells which have been inventoried at the time the well is sampled.

3. Complete the Well Specific Field Sheet (Attachment A) for water supply wells for each well sampled in the field.

K. TROUBLESHOOTING

Below is a list of commonly occurring problems and possible remedies.

Problem: Conductivity meter unresponsive, erratic or sluggish.

Solution: a) Check batteries and replace, if necessary.

b) Check that cell is completely immersed and is not touching bottom or sides of container. Trapped air can depress the conductivity reading. Immersion must be at least 1/2" above the uppermost air vent and sample must be free of air bubbles.

c) Check that electrodes are clean. Chemical cleaning may be necessary.

d) Check for obstructions in cell and remove if necessary.

e) Check that probe jack is dry. A wet probe jack can cause an unstable response.

Problem: Sample not coming through filter adequately.

Solution: a) Filter paper may be clogged--change if necessary. If sample is very turbid, use a pre-filter.

b) Check that pumping rate is sufficient to pull sample through filter.

c) Reverse flow direction for a few seconds.

d) Tighten nuts on filter to prevent leakage.

e) Check for holes in tubing.

Problem: Bailer lost in well (line becomes detached).

Solution: Try using a fishing line and hook or hanger to retrieve the bailer.

Problem: Lock on well cap is frozen.

Solution: Try using a lighter or match to heat the lock. Try blowing on the lock.

ATTACHMENT A

Well Specific Field Sheet (WSFS) - Water Supply Wells

Fill out one copy of this form for each monitoring well which is sampled.

Name of Well Owner: _____ Date: _____

License or Permit #_____ Weather Conditions: _____

Location: _____

Persons Sampling: _____

Well verified on well constr. report? (Y/N) _____

Depth to water in well (if measured)* _____

Depth to bottom of well (if measured)* _____

Depth to bottom of casing (if measured)* _____

Location of tap used for purging (before or after pressure tank)_____

_____

Length of time for purging _____

Location of tap used for sampling (before or after pressure tank) _____

_____

Time of sampling _____

Field temperature (°C) _____

Field conductivity (uncorrected) _____

Time _____

Field conductance (at 25°C)_____

Field pH (std. units) _____ Time _____

Color (Y/N) _____ Odor (Y/N) _____

Turbidity (Y/N) _____

Comments: _____

_____

_____

_____

*Describe how measured in Comments section.

ATTACHMENT B

Bottle Types, Sample Volumes and Preservation Requirements

Parameter	Required Bottle Type (mL)	Volume Required (mL)	Preservative[1]	Volume of Preservative Required[2]
Alkalinity	625	50	Cool, 4°C	—
Alkalinity-Gran Technique[3]	125	100	Cool, 4°C	—
Biochemical Oxygen Demand, 5 Day	625	100	Cool, 4°C	—
Biochemical Oxygen Demand, Long Term[4]	Quart	2200[5]	Cool, 4°C	—
Boron	60	25	Cool, 4°C	—
Chemical Oxygen Demand	250	50	H_2SO_4 to pH<2, Cool, 4°C	2 mL 12.5%(4.5 H_2SO_4/250 mL
Chloride	625	25	none required	—
Chloride, I.C.[6]	60	5	Cool, 4°C	—
Chlorophyll a	Quart	1000-3000*	Cool, 4°C, keep in dark	—
Color	625	50	Cool, 4°C	—
Corrosivity	Quart	1000	none required	—
Cyanide[7,8], Total	Quart	1000*	NaOH to pH>12, Cool, 4°C	about 5 NaOH pellets/quart
Cyanide[7,8], Amenable to Chlorination	Quart	1000	NaOH to pH>12, Cool, 4°C	about 5 NaOH pellets/quart
Fluoride	625,60	25	none required	—
Metals, Ag, Al, As, Ba, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Se, Sn, Zn, Hardness (all metals except Hg, Cr^{+6})	250 Metals	250*	HNO_3 to pH<2	2.5 mL 35% (8N HNO_3 to pH<2
Hexavalent Chromium	250 Metals	50	Cool, 4°C	—
Mercury	250 Metals	250*	HNO_3 to pH<2	2.5 mL, 35% (8N) HNO_3
Nitrogen, Ammonia	250	25	H_2SO_4 to pH<2, Cool, 4°C	2 mL, 12.5% (4.5N) H_2SO_4/ 250 mL
Nitrogen, Nitrate plus Nitrite	250	25	H_2SO_4 to pH<2, Cool, 4°C	2 mL, 12.5% (4.5N) H_2SO_4/ 250 mL
Nitrogen, Nitrate, I.C.[6]	60	5	Cool, 4°C	—

Parameter	Required Bottle Type (mL)	Volume Required (mL)	Preservative[1]	Volume of Preservativ Required[2]
Nitrogen, Nitrate plus Nitrite (Drinking waters Only)	60	25	None required	-
Nitrogen, Total Kjeldahl	250	25	H_2SO_4 to pH<2, Cool, 4°C	2 mL 12.5% (4.5N) H_2SO_4 250 mL
Oil and Grease	Quart Glass Mason	1000*	H_2SO_4 to pH<2, Cool, 4°C	4 mL (2 ampul 12.5% (4.5N) H_2SO_4/Qua
pH (Determine on site)	625	25	Determine on site Lab pH for reference only	—
Phenol	Quart Glass Mason	1000*	H_2SO_4 to pH<2, Cool, 4°C	4 mL (2 ampul 12.5% (4.5N H_2SO_4/Qua
Phosphorus, Dissolved (For special studies, may be filtered on site)	60	25	Cool, 4°C	—
Phosphorus, Total	250	25	H_2SO_4 to pH<2,	2 mL, 12.5% (4.5N) H_2S 250 mL
Reactivity - explosives	30	0.01 grams	—	—
Residue, Dissolved (Filterable)	625	50	Cool, 4°C	—
Residue, Total and Total Volatile	625	50	Cool, 4°C	—
Residue, Suspended (Nonfilterable), and Volatile Suspended	625	200	Cool, 4°C	—
Silica, Dissolved	625, 60	25	Cool, 4°C	—
Specific Conductance	625	50	Cool, 4°C	—
Sulfate	625	25	Cool, 4°C	—
Sulfate, I.C.[6]	60	5	Cool, 4°C	—
Sulfide	625	625*	Add zinc acetate, minimize air contact, Cool, 4°C	18 drops 2N zi acetate/625 m
Sulfite	625	625*	Add EDTA, minimize air contact, Cool, 4°C	6 mL EDTA solution/62 m
Surfactants (MBAS)	625	250	Cool, 4°C	—

Parameter	Required Bottle Type (mL)	Volume Required (mL)	Preservative[1]	Volume of Preservative Required[2]
Toxic Extraction Procedure	Quart Glass Mason	Call Lab[9]	—	Do Not Preserve
Turbidity	625	25	Cool, 4°C	—

* Volume includes Quality Control effort.

1 Sample preservation should be performed immediately upon sample collection. DO NOT add chemical preservatives to solid and hazardous waste samples. Composite samples that require multiple preservations should be preserved only by maintenance at 4°C until the compositing and sample splitting are completed.

2 This is the volume of preservative generally found to be sufficient to achieve the proper pH. However, additional preservative may be required in highly buffered samples. The final pH of preserved samples should be verified with pH paper.

3 This test is only performed after approval by the DNR Lab coordinator. Special 125 mL bottles are available from the Laboratory. Contact the Lab for instructions.

4 Most Long Term BOD samples require seeding. Submit a 250 mL plain bacteria bottle of receiving surface water, collected down stream from the discharge, for the seed material.

5 The Long Term BOD volume requirement depends on the expected BOD_5.
For example, samples with an expected BOD_5 of <20 mg/L require 2200 mL of sample to set up a long term BOD test, while those with an expected BOD_5 between 20-50 mg/L require 1000 mL, and with an expected BOD_5 of >50 mg/L require 500 mL.

6 Ion chromatography (IC) analysis only. Special arrangements must be made through the DNR Lab coordinator before the analyses can be performed by the Lab.

7 Cyanide samples containing residual chlorine should be treated with 0.6g ascorbic acid/L of sample at the time of collection. The sample collector should make arrangements with the lab to obtain the ascorbic acid.

8 Sulfide will interfere with the cyanide test and must be removed before the pH is adjusted. If sulfide is present, contact the lab for special instructions before collecting the sample.

9 A minimum of 100 g sample is required to perform the analysis. Call the laboratory to confirm the sample size necessary for quality control checks.

ATTACHMENT C

Chain of Custody for Enforcement Samples

To be admissible as evidence, sample results must be traceable back through their collection, shipment and analysis so that the court is satisfied how the sample results submitted as evidence were collected, transferred and claimed. This is accomplished by a written record which documents the sample identity from collection to introduction as evidence.

Field records which identify sampling personnel, sampling techniques and field conditions are required. The field investigator is responsible for maintaining sample custody until the State Laboratory of Hygiene (SLOH) accepts the sample in person.

A sample is in custody if it is:

1. In physical possession, or

2. In view, after being in physical possession, or

3. Locked up so that no one can tamper with it.

Two degrees of chain of custody have been accepted by the courts. The first, described above, involves physical possession of the sample from collection to lab possession. With this method, the investigator personally delivers the sample to the lab and picks it up. The second is by sample shipment through mail carriers.

In both cases, a written record must be transferred with the samples. However, in the second method, the collector fills out the chain of custody record, seals it in a shipping container, and ships it by U.S. mail to the SLOH. Upon arrival, a pre-determined (from prior laboratory scheduling) laboratory custodian collects the sample, notes its condition (whether sealed or unsealed) and maintains lab chain of custody records.

For routine surveillance samples, the second method of sample chain of custody should suffice. If enforcement action is likely to occur based on the samples, the first method of physical possession is recommended.

A. Field Chain of Custody Procedures

   1. Limit sample handling to as few people as possible. If transfers are necessary, signed receipts should be used. (The attached Chain of Custody Record form should accompany the sample.) The sampler should keep a copy for his/her own records.

   2. If sample is suspected to be hazardous, a receipt for each sample collected shall be given to the property or facility owner (s. 144.69, Wis. Stats.) The owner may request a split sample.

   3. Follow Handling and Preservation Handbook and Quality Assurance Handbook for sampling procedures.

4. Record field measurements and other important data in a bound field book.

5. Complete appropriate lab slip and attach to chain of custody record.

6. When necessary, document sample locations, pollution sources, violations, etc., with photographs.

7. Maintain physical possession of collected samples until properly transferred to the SLOH sample custodian.

8. Obtain a sample receipt from the SLOH custodian on transfer of samples to the lab.

B. Packing Enforcement Samples

This is the procedure which must be followed in packing enforcement samples in order to maintain the chain of custody.

1. Tape the field pack shut using nylon-reinforced tape. The ends should be straight and should be overlapped slightly.

2. Using a waterproof pen, write the following information on the tape, and over the overlapping ends.

   a. Name of person taking sample, date, time and water body, facility, etc., where the sample was taken.

   b. The words "ENFORCEMENT CASE."

   c. The words "To be opened by _____ personnel only." In the blank specify water chemistry unit, air chemistry unit, pesticides and organic chemistry unit, or water microbiology unit, as appropriate.

   d. If all the samples are organic, specify "organic". If they are all inorganic, specify "inorganic".

   By overlapping the edges of the tape and writing over them you'll be able to tell whether someone has tampered with the field pack. If the tape has been removed, it will be difficult to get the writing correctly lined up when the tape is put back on.

   Do not use sealing wax to seal the tape. Sealing wax is brittle and will chip and break during normal use. This gives the appearance of tampering even when none has taken place.

Field packs which are labeled ENFORCEMENT CASE are locked up by the State Lab as soon as they arrive and are not taken out until they are analyzed. When they are taken out, a red "ENF" is stamped on the sample bottle and on the corresponding lab slip. A number is placed on the bottle which corresponds to the number on the lab slip. Enforcement samples are kept in sight at all times when they are being worked on, and are locked up again as soon as the work is done.

The lab will keep all enforcement samples until notified that the samples are no longer needed. When an enforcement case is resolved, either by stipulation or trial, the enforcement specialist should notify the lab that the samples connected with that case may be discarded.

State of Wisconsin
Department of Natural Resources

CHAIN OF CUSTODY RECORD
Form 4100-145 7-87

Sample Collector(s)	Title/Work Station	Telephone No. (include area code)
Property Owner	**Property Address**	**Telephone No. (include area code)**

Spit Samples: Offered? ☐ Yes ☐ No (Check One)
Accepted? ☐ Yes ☐ No (Check One) **Accepted By:** _____
Signature

Sample ID No.	Date	Time	Sample Type		Station Location Sample Description	Lab ID Number	No. of Containers	Comments
			Comp	Grab				

I hereby certify that I received, properly handled, and disposed of these samples as noted below:

Relinquished By (Signature)	Date/Time	Received by: (Signature)
Relinquished By (Signature)	Date/Time	Received by: (Signature)
Relinquished By (Signature)	Date/Time	Received for Laboratory By: (Signature)

Disposition of Unused Portion of Sample:

Dispose _____ Retain for _____ days

Return _____ Other _____

ATTACHMENT L

Department of Natural Resources

GROUNDWATER MONITORING INVENTORY FORM

Form 3300-67 Rev. 1-86

File Maintenance Code: A — Add (New Facility)
C — Change (Existing Facility)
D — Delete from Inventory

Form completed and sample collected by — Date: M M D D Y

Directions on reverse side of form. Volatile Organic Sampling Program ☐ Pesticide Program ☐ Other ☐

1. INVENTORY INFORMATION Mandatory Information (See Instructions)

Present name of establishment or facility (public system)

Facility I.D. or Check Here If New Facility ☐

Name of owner or manager (last name first)

Owner's Address (street or route)

Area code | Telephone number

City | State | Zip Code

County | Co. code | Township

Name of occupant (if different than owner) (last name first)

Occupant's address (street or route)

City | State | Zip Code

Water System Type (check ✓ one)

Nonpotable wells
☐ M Monitoring
☐ I Irrigation
☐ X Other

Potable wells
☐ M Community — municipal
☐ O Community — other than municipal
☐ N Non-community
☐ P Private

High cap. permanent well no. | Well no. | Parcel No. | Government lot number

Well Location: ¼ ¼ | ¼ Sec. | Sec. | T N | R | Town | Range

2. WELL DATA

Well Construction Report Available? ☐ Yes ☐ No

Date well constructed | Constructed by | Casing depth ft. | Depth to water ft. | Depth to bedrock ft.

Casing diameter (inches) | Distance casing above or below grade (inches) | Total well depth ft. | Water bearing formation: ☐ S — Sandstone ☐ H — Shale ☐ L — Limestone ☐ G — Granite ☐ Q — Quartzite ☐ U — Unconsolidated

3. SOURCE OF WELL DATA

☐ C — Construction Report ☐ I — Inspection Form or Sanitary Survey ☐ O — Owner or Occupant
☐ D — Well Driller ☐ N — Data Not Available

4. WELL STATUS

☐ A — Active ☐ I — Inactive ☐ B — Abandoned

5. ADDITIONAL COMMENTS (Directions to Site, Possible Contaminant Sources, See Back)

INSTRUCTIONS

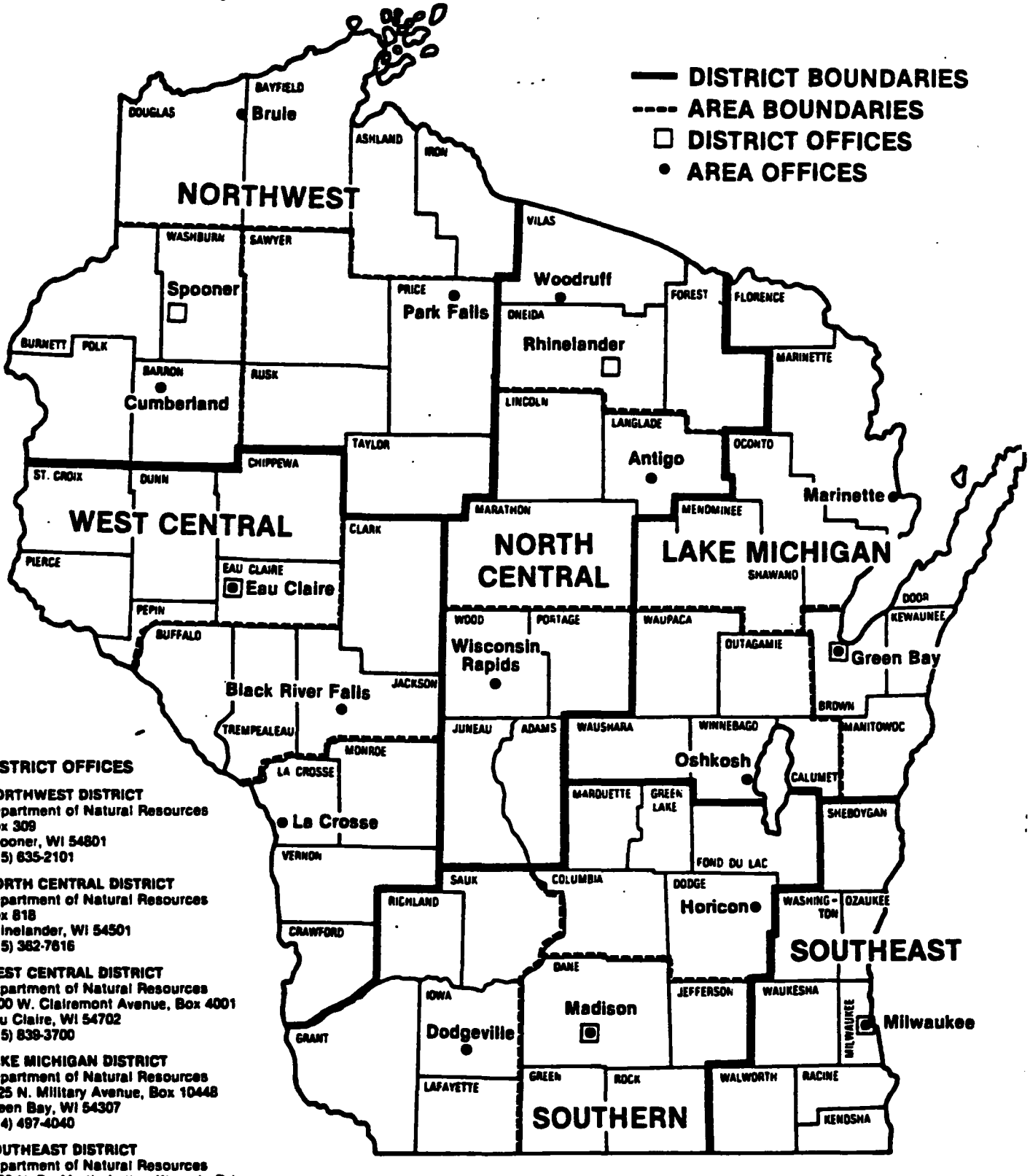
1. Complete one form for each well sampled as part of the groundwater monitoring program. Sections 1 & 3 must be completed for data entry. Mandatory fields are indicated by shadowing and must be completed or your form will not be entered on a computer file. Sections 2 & 4 provide pertinent information and must be completed if the information is available. The permanent well ID number for high capacity wells (including schools and irrigation wells) may be obtained from the Central Office Private Water Supply Section at (608) 266-0821.

2. As a minimum, the comment section (5) should include suspected contaminant source identification and directions to the facility.

3. If any information in each section is a change to existing records, please indicate this by checking the box in the upper left corner. New facilities must also be indicated in this manner.

4. If government lot numbers must be used, enter a section number also. Parcel numbers should be right justified. At a minimum, one government lot number, section number or parcel number must be recorded on this form.

DNR FIELD DISTRICTS AND AREAS



DISTRICT OFFICES

NORTHWEST DISTRICT
Department of Natural Resources
Box 309
Spooner, WI 54801
(715) 635-2101

NORTH CENTRAL DISTRICT
Department of Natural Resources
Box 818
Rhinelander, WI 54501
(715) 362-7616

WEST CENTRAL DISTRICT
Department of Natural Resources
1300 W. Clairemont Avenue, Box 4001
Eau Claire, WI 54702
(715) 839-3700

LAKE MICHIGAN DISTRICT
Department of Natural Resources
1125 N. Military Avenue, Box 10448
Green Bay, WI 54307
(414) 497-4040

SOUTHEAST DISTRICT
Department of Natural Resources
2300 N. Dr. Martin Luther King, Jr. Drive
Box 12436
Milwaukee, WI 53212
(414) 562-8500

SOUTHERN DISTRICT
Department of Natural Resources
3911 Fish Hatchery Road
Fitchburg, WI 53711
(608) 275-3266

Rev. 8-85

ATTACHMENT 1
WELL AND GROUNDWATER ELEVATIONS FROM THE REMEDIAL INVESTIGATION

Attachment 1a Well Elevations		
Well Number	**Riser Elevation (ft)**	**Ground Elevation (ft)**
New Wells		
MW-1S	663.22	660.9
MW-1M	663.47	660.9
MW-2S	664.88	662.3
MW-2M	664.93	662.9
MW-2D	665.07	662.75
MW-3S	656.44	653.7
MW-3M	655.43	653.6
MW-3D	656.46	653.9
MW-4S	665.01	662.6
MW-5S	659.46	656.4
MW-6M	648.46	646.0
MW-7M	662.51	660.3
MW-8S	661.88	659.4
MW-8M	662.63	659.4
MW-8D	661.65	659.2
MW-9M	656.10	653.6
MW-10M	656.51	653.3
MW-11M	657.17	654.3
MW-12S	662.95	660.2
MW-13S	664.87	661.8
MW-14S	656.19	654.8
Old Wells		
B-1	663.42	660.6
B-2	667.23	665.3
B-3	661.06	669.9
B-4S	656.16	655.1
B-4D	656.62	655.0
B-5	662.00	659.4

GLT272/023.51

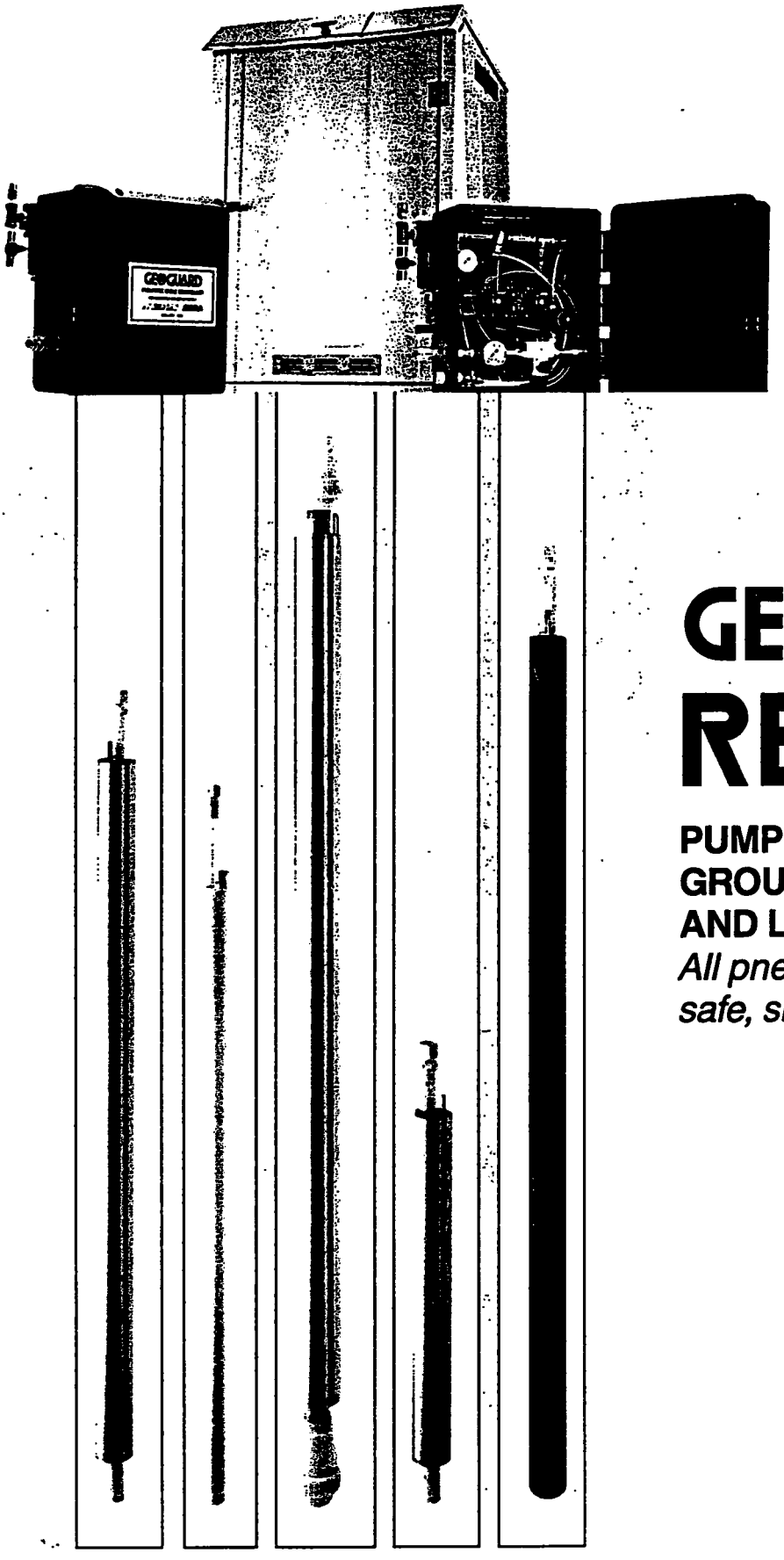
Attachment 1b
Groundwater Elevations in Feet

Well Number	6/1/88 Elevation	3/31/89 Elevation	4/17/89 Elevation	6/12/89 Elevation	8/2/89 Elevation
New Wells					
MW-1S	--	646.35	644.10	644.25	642.34
MW-1M	--	646.34	644.12	644.25	642.35
MW-2S	--	647.06	644.55	644.72	642.77
MW-2M	--	645.86	643.99	644.26	642.34
MW-2D	--	645.46	644.02	644.28	642.26
MW-3S	--	645.27	643.94	644.09	641.98
MW-3M	--	645.31	643.85	644.07	642.08
MW-3D	--	645.40	643.94	644.16	642.17
MW-4S	--	644.82	643.85	644.11	642.19
MW-5S	--	645.64	643.92	644.11	641.94
MW-6M	--	645.25	643.63	643.80	641.91
MW-7M	--	644.39	643.93	644.23	642.12
MW-8S	--	644.73	643.73	643.95	641.97
MW-8M	--	644.83	643.73	643.97	642.00
MW-8D	--	644.81	643.76	644.00	642.02
MW-9M	--	644.37	643.57	643.75	642.39
MW-10M	--	644.80	643.44	643.58	642.29
MW-11M	--	644.07	643.62	643.96	642.03
MW-12S	--	644.52	643.81	643.08	642.05
MW-13S	--	644.84	644.01	644.32	642.18
MW-14S	--	644.71	642.75	642.95	641.05

Note: River Elevation is 642.56

GLT272/024.51

ATTACHMENT 2
EXAMPLE OF PUMPING STATION

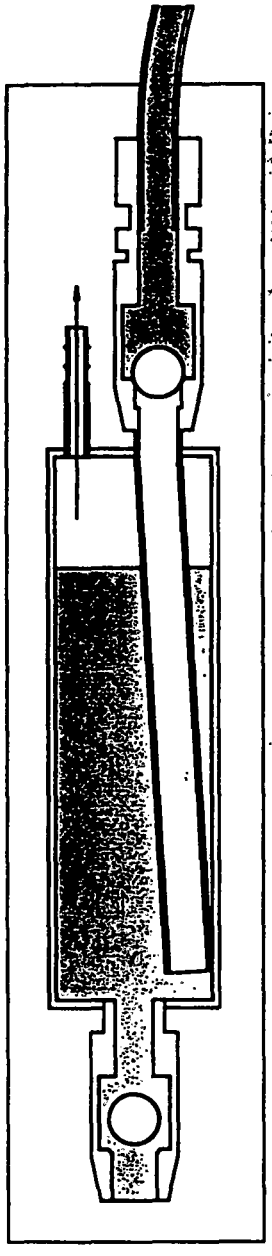


GEOGUARD®
RELIA-FLO™

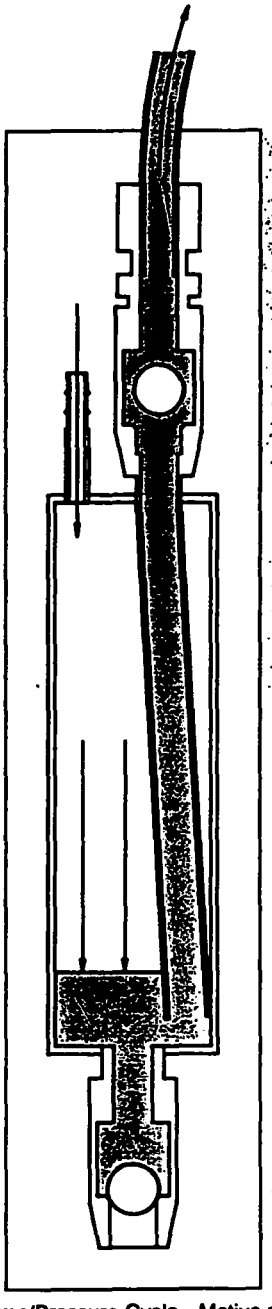
PUMPING SYSTEMS FOR GROUND WATER REMEDIATION AND LEACHATE EXTRACTION.

All pneumatic designs for safe, simple, reliable operation.

For successful ground water remediatio



Fill/Vent Cycle—Air within the pump is vented to the atmosphere. When air pressure is reduced to a value less than the static water level pressure, water enters the pump body through the bottom check valve and displaces the remaining air while filling the pump. The weight of the water in the discharge line holds the upper check valve closed.



Pump/Pressure Cycle—Motive air enters the pump body at a pressure greater than the head and closes the lower check valve while forcing the sample to exit the pump body through the dip tube and upper check valve.

Simply the best

It is estimated that up to 20% of ground water remediation costs are spent keeping the pumping system operating properly. Complicated pumping equipment, ultra-pure air quality demands, excess moving parts, and unnecessary bells and whistles often lead to equipment failure, unnecessary downtime and high project costs.

GEOGUARD® RELIA-FLO™ pneumatic pumping systems make it simple to hold remediation costs down. Because many ground water contaminants are ignitable or explosive, RELIA-FLO systems are fully pneumatic and inherently safe, without adding the complexity of explosion proofing necessary for electric systems.

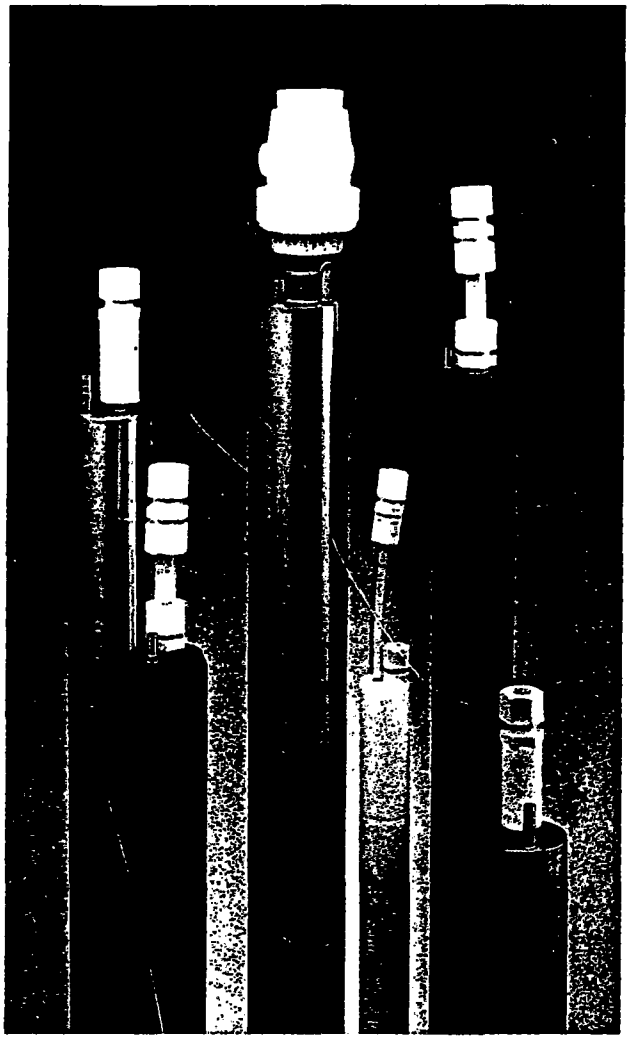
And RELIA-FLO pumps, with only two moving, self-cleaning parts, won't gum up and fail...loose ball cavity tolerances assure that. Designed without floats, magnets, valves, or tiny porting, these pumps survive sand, dry pumping and dirty air, cycle after cycle, year after year.

GEOGUARD RELIA-FLO systems also operate with 40 micron air...better than most systems on 5 micron air. Other pumping system air valves require high quality compressed air, but the pneumatic timers (the brains of the system) are fed ambient air. With over 500,000 contaminating particles in one cubic inch of atmospheric air, it is easy to see why conventional systems are so maintenance intensive. In contrast, RELIA-FLO uses a closed loop system. All air entering the control system is compressor-produced and filtered to insure long, trouble-free, valve *and* timer operation.

Easy to install and use

RELIA-FLO systems are designed for simple installation and ease of operation. Using modular, quick-connect components, hand tools are all that is required for installation. All components are easy to set up and calibrate. Simple to adjust, independent timer controls assure optimal cycling frequency under any lift and submergence condition. Flow rates are adjustable from 10 ml/min. to 18 gpm.

Specify RELIA-FLO pumping systems



With a modular design that makes modification a snap

With RELIA-FLO's modular component design, modifying a system to meet changing project needs is a snap. For example, a system can be expanded to include additional wells simply by snapping components into the system loop. You're up and running in minutes!

When one project is complete, the equipment can be re-configured and used for another. A full range of options enables the original system to be tailored to any new pumping situation.

Employing rugged, environmentally-resistant components

RELIA-FLO controllers are packaged in high density, non-corroding, high impact, NEMA 4X, lockable cases, protecting all internal components from corrosive gases and vapors.

RELIA-FLO pumps are designed to resist the most hostile of corrosive, abrasive, viscous, or high temperature liquids. Construction features large gauge threads and welded connections...using no pins that can loosen and fall out.

System tubing is available in polyethylene, nylon, or Teflon® for extended, trouble-free service life. Above ground tubing can be specially ordered to resist the degrading effects of extended exposure to sunlight.

Consult the chemical compatability tables for resistance to specific chemicals.

Notes: 1. Pump material options are PVC, Stainless or Teflon®
2. Tubing material options are Teflon®, Nylon or P.E.
3. Viton® used for o-ring seals in pumps

Backed by years of experience as close as your nearest phone

With GEOGUARD, complete, *confidential* applications assistance is just a toll free call away...**1-800-645-7654** puts our know-how to work for you!

Note: Viton® and Teflon® are registered trademarks of E.I. duPont de Nemours.

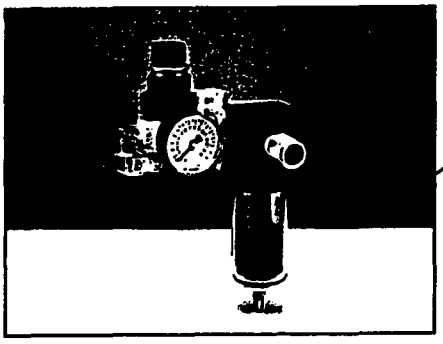
MATERIAL SELECTION GUIDE

	Gasoline	Fuel Oils	Chlorinated Solvents	Non-Chloride Acids	Hydrochloric Acid	Bases
PVC	C	A	D	B	B	A
Teflon	A	A	A	A	A	A
Stainless	A	A	B	A	D	B
Nylon	A	A	C	D	D	A
P.E.	C	C	C	C	B	A
Viton	A	A	A	A	A	A

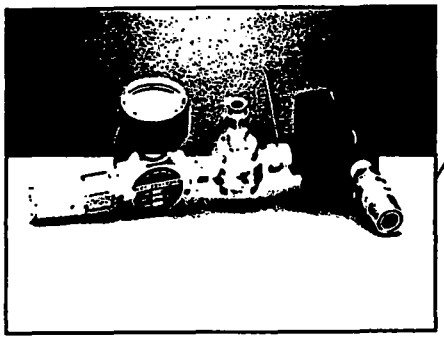
RATINGS: A—No effect-excellent
B—Minor effect-good
C—Moderate effect-fair
D—Severe effect-not recommended

Configure your system to m

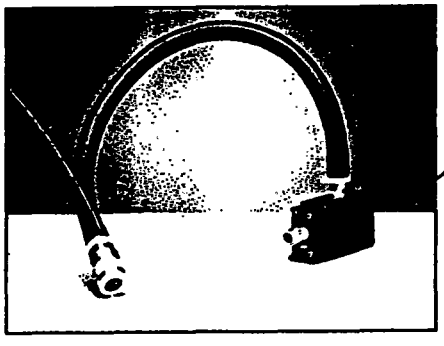
REMOTE LEVEL SHUT-OFF— Provides independent on/off pump level control in each well of a multiple well system.



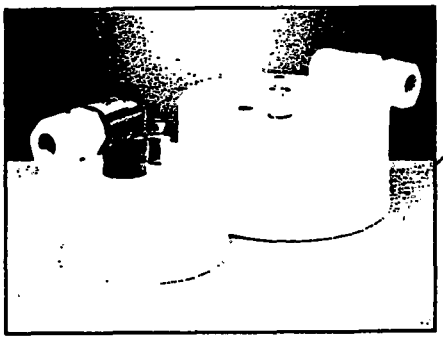
SATELLITE CONTROLLERS— Used in single controller, multiple well projects to provide a low cost alternative to supplying a primary pump cycle controller at every well.



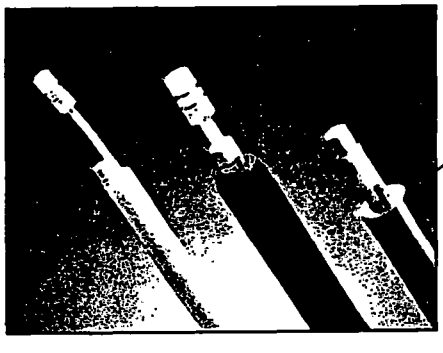
VACUUM ASSIST MODULE— Permits rapid pump filling in vacuum extraction systems.

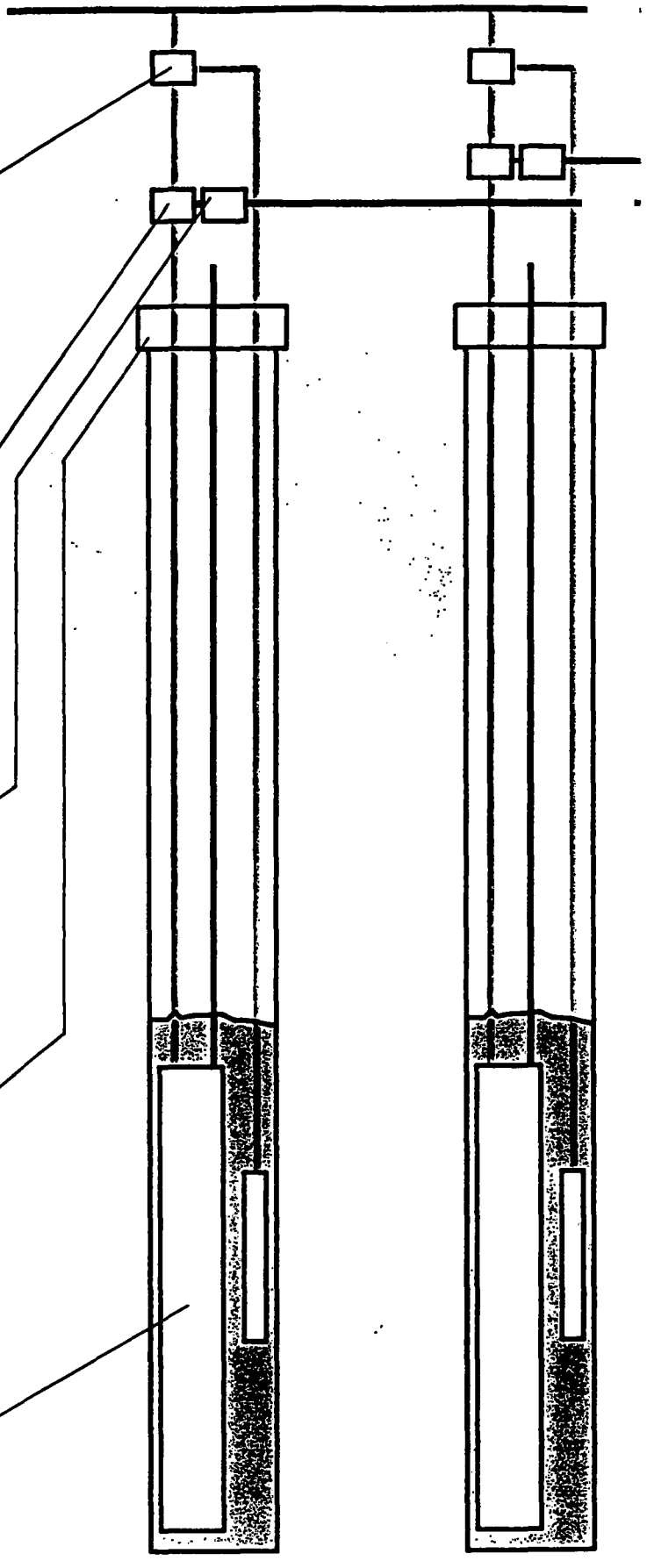


WELLHEAD CLOSURE— Durable, PVC construction, wellhead closures provide a means of terminating tubing to the wellhead, supporting the pump, and housing the air and water fittings.

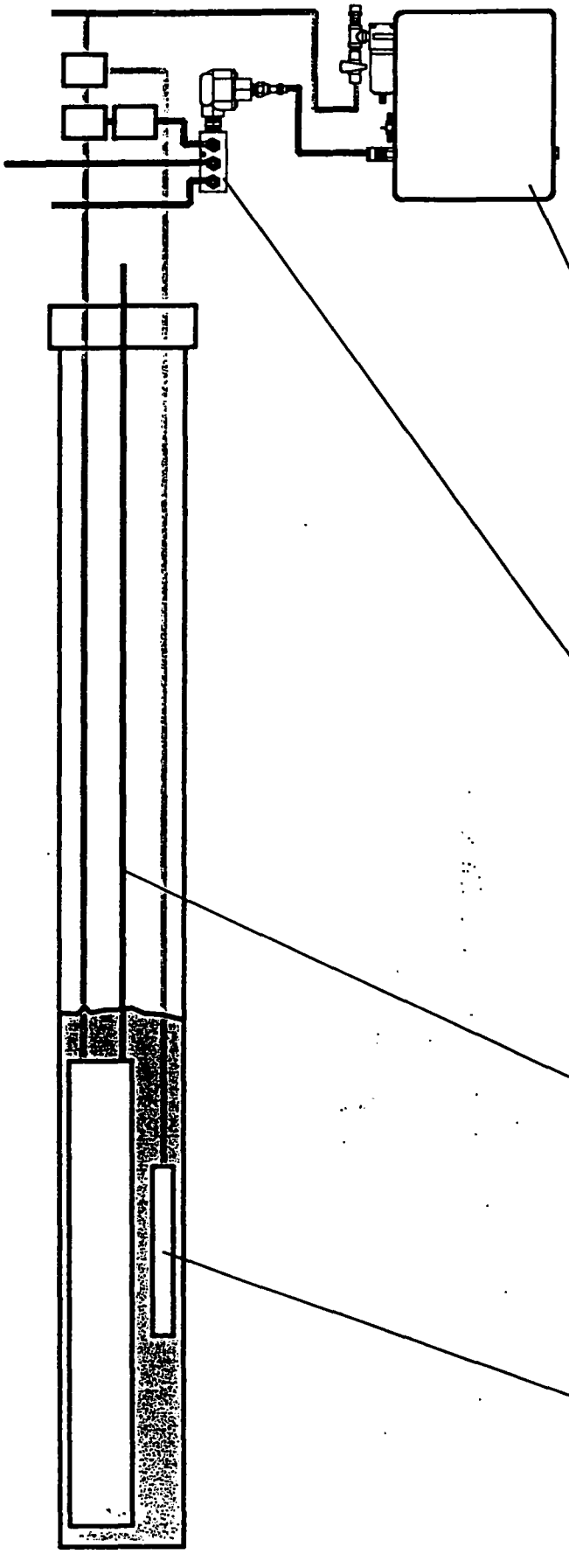


PUMPS— Fully pneumatic, employing only two moving parts, both 2" and 4" gas drive pumps are available in PVC, Stainless Steel/Teflon, or all Teflon.



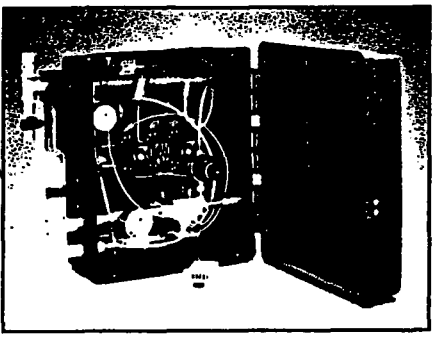


tually any pumping situation

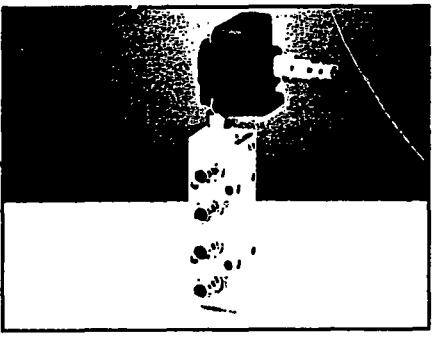


COLOR KEY:

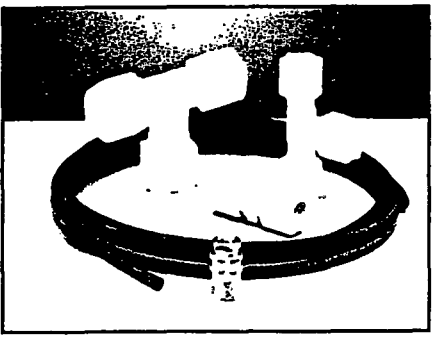
- RED ..... Logic Control
- GREEN ..... Level Control
- BLUE ..... Drive Air
- BLACK ..... Liquid Discharge



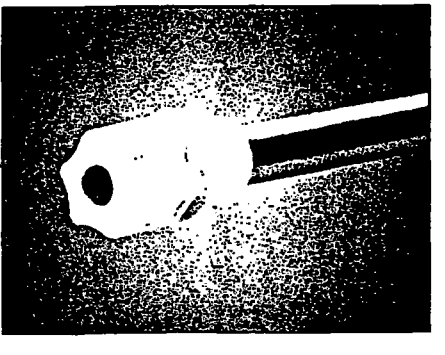
CYCLE CONTROLLERS— Fully pneumatic, adjustable, automatic cycle controllers determine pump fill and discharge rates. Available with or without on/off pump level control and cycle counter.



MANIFOLD WITH QUICK EXHAUST— Used in single controller, multiple well systems to distribute air signal uniformly to satellite controllers.

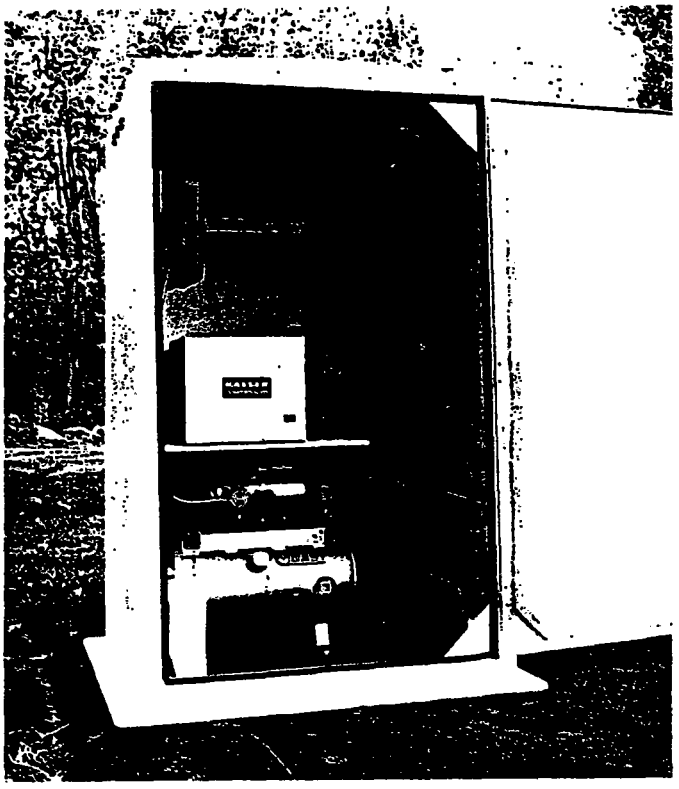


TUBING— Available in polyethylene, nylon, or Teflon® to match your pumping application.



BUBBLER PROBE— Weighted, stainless steel probe which allows bubbler tubing to be installed independent of the pump position.

Self-contained pumping systems



Many long term projects, or projects in highly visible areas, benefit from secure, unobtrusive, equipment installations.

In these situations, RELIA-FLO pumping systems are custom assembled as complete, self-contained, enclosed units, with all instrumentation and accessories pre-installed and ready for mounting on a concrete pad. Bring in your lines and your ground water pumping system will be operating in minimum time.

Protected from the adverse effects of environmental exposure, tampering, or the curious public, RELIA-FLO fully enclosed, Self-Contained Pumping Systems feature:

- Pneumatic recovery pump...gas drive or bladder.
- Pump cycle controller to manage compressed air delivery to the down-well pump.
- Air compressor, with ASME-coded receiver tank, to specification.
- Refrigerated air dryer, electrically-driven and installed after the receiver tank, to cut water condensation in pneumatic control lines.
- FRP Enclosure, with locking access door(s).
- Breaker box and grounded receptacles for safe, electric service.
- Light, heater, exhaust fan, window, as needed.
- Explosion proofing, when and where required.