Appendix B

Supporting Information for RCRA Units

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Supporting Information for RCRA Units

Supplemental information for *Resource Conservation and Recovery Act* (RCRA) units on the Hanford Site that require groundwater monitoring is provided in this appendix. RCRA regulations are administered under the Washington Administrative Code (WAC) 173-303. Text and tables include the information required by RCRA regulations essential for assessing the adequacy of the monitoring networks. RCRA groundwater monitoring continued during fiscal year 2003 at 24 waste management areas Figure B.1. RCRA units are discussed in alphanumeric order. One new facility, the Integrated Disposal Facility, is scheduled to begin groundwater monitoring in fiscal year 2004 and is included in the descriptions. Table B.1 lists the monitoring status for RCRA facilities at the end of fiscal year 2003. Estimates of groundwater velocity, hydrologic properties, and associated references are shown in Table B.2 for all RCRA sites. Table B.3 lists the RCRA wells that were not sampled as scheduled during fiscal year 2003.

B.1 116-N-1 (1301-N) Liquid Waste Disposal Facility

The 116-N-1 liquid waste disposal facility is included in the Hanford Facility RCRA Permit (Ecology 1994) and is, therefore, subject to final status monitoring requirements. However, the closure plan (in DOE/RL-96-39) states that RCRA monitoring during closure activities will follow the requirements of BHI-00725. That plan, and a supplemental plan (PNNL-13914), describe an interim status indicator evaluation program (40 CFR 265, as referenced by WAC 173-303-400).

Upgradient and downgradient wells were sampled twice in fiscal year 2003 for contamination indicator parameters (pH, specific conductance, total organic carbon, and total organic halides) and once for groundwater quality and site-specific parameters, as planned (Table B.4). Due to broken sample bottles, only three replicates for total organic carbon and total organic halides were analyzed in September in upgradient well 199-N-34.

Downgradient well 199-N-3 had pH values below the critical range in March and September 2003. The U.S. Department of Energy (DOE) submitted an assessment report on a previous exceedance[(a)] to the Washington State Department of Ecology (Ecology) concluding that the below-background pH is characteristic of the area and does not appear to indicate contamination from the facility. Detection monitoring will continue.

Specific conductance in well 199-N-3 exceeded the critical mean value in March and September 2003. Such exceedances are common in this well, and are related to a non-hazardous, high-conductance plume (WHC-SD-EN-EV-003).

The groundwater flow direction is not expected to change in the near future, and there are no plans to modify the network in fiscal year 2004. Upgradient/downgradient comparison values for indicator parameters have been revised based on recent data for use in fiscal year 2004 comparisons (Table B.5).

B.2 120-N-1 and 120-N-2 (1324-N/NA) Facilities

The 120-N-2 (1324-N) surface impoundment and 120-N-1 (1324-NA) percolation pond are included in the Hanford Facility RCRA Permit (Ecology 1994) and are thus subject to final status monitoring requirements. However, the closure plan (in DOE/RL-96-39) states that RCRA monitoring during closure activities will follow the requirements of BHI-00725. That plan, and a supplemental plan (PNNL-13914), describe an interim status indicator evaluation program (40 CFR 265, as referenced by WAC 173-303-400).

(a) Letter report 02-GWVZ-0029 from JG Morse (U.S. Department of Energy, Richland, Washington) to JA Hedges (Washington State Department of Ecology, Kennewick, Washington), *Notification of Exceedance of Critical Range for pH in 1301-N Facility*, dated July 8, 2002.

During fiscal year 2003, four of the five monitoring wells for this site were sampled twice for contamination indicator parameters and groundwater quality and site-specific parameters, as planned (Table B.4 and Figure B.2). Downgradient well 199-N-59 contained too little water to sample in March and September 2003.

Average specific conductance values in wells downgradient of the facilities continued to exceed the critical mean values in fiscal year 2003. A previous groundwater quality assessment indicated that the high specific conductance is caused by the non-hazardous constituents sulfate and sodium (WHC-SD-EN-EV-003). Because an assessment has already been completed and non-hazardous constituents caused the high conductance, detection monitoring will continue.

The groundwater flow direction is not expected to change in the near future, and there are no plans to modify the network in fiscal year 2004. Upgradient/downgradient comparison values for indicator parameters were revised based on recent data for use in fiscal year 2004 comparisons (Table B.6).

B.3 116-N-3 (1325-N) Liquid Waste Disposal Facility

The 116-N-3 liquid waste disposal facility is included in the Hanford Facility RCRA Permit (Ecology 1994) and is, therefore, subject to final status monitoring requirements. However, the closure plan (in DOE/RL-96-39) states that RCRA monitoring during closure activities will follow the requirements of BHI-00725. That plan, and a supplemental plan (PNNL-13914), describe an interim status indicator evaluation program (40 CFR 265, as referenced by WAC 173-303-400).

During fiscal year 2003, upgradient and downgradient wells were sampled twice for contamination indicator parameters (pH, specific conductance, total organic carbon, and total organic halides) and once for groundwater quality and site-specific parameters, as planned (Table B.4 and Figure B.2).

Average specific conductance values in downgradient well 199-N-41 continued to exceed the critical mean value in fiscal year 2003. This was a continuation of previous exceedances noted in 1999 through 2002. DOE notified Ecology of that original exceedance and submitted an assessment report that concluded the exceedance was caused by past discharges of non-hazardous constituents. Detection monitoring will continue in fiscal year 2004.

Groundwater flow direction is not expected to change in the near future, and there are no plans to modify the networks during fiscal year 2004. Upgradient/downgradient comparison values for indicator parameters were revised based on recent data for use in fiscal year 2004 (Table B.7).

B.4 116-H-6 (183-H) Evaporation Basins

This unit continued to be monitored in accordance with a final status corrective-action program during fiscal year 2003 (WAC 173-303-645(11)(g). The unit was incorporated into the Hanford Facility RCRA Permit (Ecology 1994). Groundwater remediation is integrated with the 100-HR-3 Operable Unit, where remediation for chromium is underway. While the pump-and-treat system is operating, RCRA monitoring consists of annual sampling of four wells for chromium, fluoride, nitrate, technetium-99, and uranium (Table B.8 and Figure B.3). The objective of monitoring during the operation of the pump-and-treat system is to determine whether concentrations of the contaminants of concern are decreasing. DOE will propose a change to the monitoring requirements with a permit modification in fiscal year 2004. The proposed change will bring the site under a post-closure monitoring program that is integrated with the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) monitoring program, as allowed under Section II.K.7 of the Hanford Facility RCRA Permit (Ecology 1994).

All wells were sampled in November 2002, as planned. Two semiannual letter reports[(b)] that document the effectiveness of the corrective action program were submitted to Ecology during fiscal year 2003. The current monitoring network was designed to accommodate groundwater flow imposed by the pump-and-treat system, and no changes are planned for fiscal year 2004.

(b) Letter report 03-WMD-0183 from JG Morse (U.S. Department of Energy, Richland, Washington) to JA Hedges (Washington State Department of Ecology, Kennewick, Washington), *Resource Conservation and Recovery Act (RCRA) Final Status/Corrective Action Semiannual report for July through December, 2002*, dated May 29, 2003.
Letter report 04-AMCP-0078 from KA Klein (U.S. Department of Energy, Richland, Washington) to JA Hedges (Washington State Department of Ecology, Kennewick, Washington), *Resource Conservation and Recovery Act (RCRA) Final Status Corrective Action Semiannual Reports for January Through July [sic] 2003*, dated November 26, 2003.

B.5 216-A-29 Ditch

The 216-A-29 ditch (Figure B.4) is an inactive RCRA facility that is monitored under an interim-status indicator evaluation program (PNNL-13047). The facility has recorded past indicator parameter exceedances for specific conductance. These exceedances continued into fiscal year 2003, with specific conductance exceeding the critical mean of 265 µS/cm in three wells: 299-E25-35, 299-E25-48, and 299-E26-13. The first two of these three wells are at the head end of the decommissioned facility; the rise in specific conductance is attributed to manmade sulfate, a non-hazardous constituent. The rise in well 299-E26-13 cannot be definitively attributed to the rise in sulfate observed at the head end of the 216-A-29 ditch. The concentration rise in this well is similar to a regional elevation of sulfate concentrations throughout the east portion of the 200 East Area. The network wells and constituents list are provided in Table B.9 and statistical comparison data for fiscal year 2004 are listed in Table B.10.

B.6 216-B-3 Pond

The current monitoring network for the 216-B-3 pond (B Pond) system includes three downgradient wells and one upgradient well (Figure B.5). Samples were collected semiannually in these wells during fiscal year 2003 for the list of constituents shown in Table B.11.

For the past 2 years, groundwater monitoring has been conducted under a temporary variance granted by Ecology. The variance allowed for a trial period of intrawell data comparisons for site-specific constituents. The alternative statistical method used consists of the Shewhart-Cumulative Sum (CUSUM) calculation to determine long-term trends and that is also sensitive to sudden shifts in mean concentrations for each well individually. Baseline data, control limits, and summary statistics for gross beta and specific conductance are reported in Appendix A of PNNL-14187. The variance monitoring was governed by PNNL-13367-ICN-1.

Beginning in January 2004, the facility will return to indicator-parameters-evaluation status using upgradient/downgradient comparisons until the results of the variance period are evaluated. Critical means for statistical comparisons, which begin in January 2004, are listed in Table B.12. Based on the results of this trial evaluation, Ecology will decide whether to continue, modify, or abandon the alternative approach. During fiscal year 2003, the Shewhart mean-plus-two-sigma level was briefly (and marginally) exceeded in well 699-43-45 for specific conductance. This increase is interpreted as a return to background water quality, following dilution by B Pond discharges (see Section 2.11.3).

B.7 216-B-63 Trench

Indicator parameter monitoring at the 216-B-63 trench has not provided any evidence of contamination from the facility. Two downgradient wells (299-E33-36 and 200-E33-33) (Figure B.6) exceeded the critical mean for total organic carbon in fiscal year 2003, but the exceedance may be part of an analytical problem with an instrument at one of the contract laboratories supporting the Groundwater Performance Assessment Project (groundwater project) (see discussion in Appendix D). Monitoring wells and the constituent list for the 216-B-63 trench are provided in Table B.13. Critical means for statistical comparison in fiscal year 2004 are listed in Table B.14.

B.8 216-S-10 Pond and Ditch

During fiscal year 2003, this facility continued to be monitored semiannually under a RCRA interim status indicator evaluation program (Table B.15 and Figure B.7). Statistical evaluations of indicator parameter data have not indicated that the facility has affected the groundwater quality in the uppermost aquifer beneath the site. Upgradient/downgradient comparison values for fiscal year 2004 are listed in Table B.16. The direction of groundwater flow and estimated flow rate are listed in Table B.2. During fiscal year 2003, upgradient well 299-W26-7 went dry and one new downgradient well, 299-W26-14, was added. Before well 299-26-7 went dry, it was sampled twice (December 2002 and June 2003) in fiscal year 2003. The current monitoring network for the 216-S-10 pond and ditch consists of only two shallow downgradient wells and one deeper downgradient well (Table B.15).

Ecology and DOE annually negotiate installation of future monitoring wells under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement; Ecology et al. 1998) Milestone M-24. The chromium concentration

increased in well 299-W26-7 during fiscal year 2003 to a maximum of 209 µg/L in June 2003 before the well went dry. The new groundwater monitoring plan (PNNL-14070) proposes deepening the upgradient well 299-W26-7 and one other dry downgradient well. Analytical results from the 216-S-10 pond and ditch are discussed in Section 2.9.

B.9 216-U-12 Crib

This RCRA unit continued to be monitored under an interim status groundwater quality assessment program in fiscal year 2003. A new assessment monitoring plan (PNNL-14301) for the 216-U-12 crib was published during 2003. Assessment monitoring began in 1993 because of elevated specific conductance in two downgradient wells. In fiscal year 2003, network monitoring wells were sampled quarterly for constituents of interest (Table B.17 and Figure B.8).

Based on the results of the assessment investigation (PNNL-11574), the site remains in interim status assessment monitoring because of continued elevated levels of nitrate. Site-wide monitoring evaluates the extent of this plume. The rate and direction of groundwater flow (Table B.2) and the extent of contamination at this site are discussed in Section 2.9.

The crib will not receive additional effluents and is scheduled, according to PNNL-14301, to be closed under an accelerated schedule in accordance with the CERCLA 200-UP-1 Operable Unit planned focused feasibility study (DOE/RL-2003-23) and proposed plan (DOE/RL-2003-24). This process will integrate closure and post-closure requirements for the 216-U-12 crib. As part of this proposed plan (DOE/RL-2003-24), the crib will be closed by September 30, 2006.

Currently, the crib is monitored by only two downgradient wells (299-W22-79 and 699-36-70A) because of declining water levels. Ecology and DOE annually negotiate installation of future monitoring wells under Tri-Party Agreement (Ecology et al. 1998) Milestone M-24.

B.10 316-5 Process Trenches

The 316-5 process trenches are in a RCRA final status program and groundwater monitoring is conducted in accordance with WAC 173-303-645(11), Corrective Action Program, and Part VI, Chapter 1 of the Hanford Facility RCRA Permit (Ecology 1994). The modified closure plan (DOE/RL-93-73), which is incorporated into the Hanford Facility RCRA Permit, indicates that groundwater remediation is deferred to the CERCLA 300-FF-5 Operable Unit.

The objective of groundwater monitoring during the corrective action period is to demonstrate the effectiveness of the corrective action program by examining the trend of the constituents of interest to confirm that they are attenuating naturally, as expected by the CERCLA record of decision for the 300-FF-5 Operable Unit (ROD 1996). In September 2001, a revised groundwater monitoring plan (PNNL-13645) was implemented for a 2-year evaluation period. Changes over the previous plan included an update on the discussion of hydrogeology and the conceptual model, a change in the number of network wells from 8 to 11 (Figure B.9), and evaluation of the statistical approach to the control chart method (Shewhart-CUSUM). The last groundwater samples collected for this 2-year evaluation period were collected in September 2003. The data will be evaluated, and a report on the 2-year evaluation will be presented to Ecology in fiscal year 2004.

The 300 Area process trenches were closed under a modified closure/post-closure plan (DOE/RL-93-73) and continue to be in the groundwater corrective action program because groundwater contamination continues to exceed groundwater quality criteria (federal drinking water standards). Groundwater monitoring will continue for 30 years during the post-closure monitoring period. The new groundwater monitoring plan (PNNL-13645, hereafter called the revised plan) was submitted to Ecology and was released for public comment in May 2002. This revised plan was in effect under a temporary authorization granted by Ecology for the 2-year trial period. However, because the latest modification of the Hanford Facility RCRA Permit specifies WHC-SD-EN-AP-185 (the previous plan), both plans are being used.

The most significant difference between the previous and revised groundwater monitoring plans is the change in statistical approach. The revised statistical approach is a control chart method that uses a single observation (sample) during any monitoring event rather than four time-independent samples specified by the previous plan. The method monitors each well in the network individually and yet maintains desired site-wide false-positive and false-negative rates. Also, each well showing an exceedance of the drinking water standard of one of the constituents of interest is sampled quarterly to better follow the trends of contaminant concentration. The other wells in the network will continue to be sampled semiannually. To implement the previous plan, four time-independent groundwater samples

are collected at eight wells twice per year (semiannually). However, to accomplish the time independence between the four samples in a sampling period, the samples are collected in 1-month intervals. The result is that under the previous plan (WHC-SD-EN-AP-185), groundwater samples are collected from the eight network wells for 8 months per year (December, January, February, March, June, July, August, and September).

The revised groundwater monitoring network for the 316-5 process trenches (Figure B.9) includes five well pairs plus one additional well (399-1-11) that is screened in the upper portion of the unconfined aquifer. Each of the well pairs has one shallow and one deep well. The shallow wells are screened at the water table, and the deep wells are screened at the bottom of the unconfined aquifer (above the lacustrine and overbank deposits of the Ringold Formation lower mud unit).

The wells are sampled for the constituents of interest, including total uranium (chemical), and the volatile organic compounds cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene (Table B.18). The sampling schedule is based on the concentrations of the constituents of interest reported at each well. Wells with constituents of interest exceeding drinking water standards are sampled quarterly. The rest are sampled semiannually.

To be in compliance with the previous plan (WHC-SD-EN-AP-185), groundwater samples are collected during the 8 months specified earlier at four well pairs (one shallow and one deep). The constituents of concern are the same as in the revised plan (PNNL-13645). Where the two plans overlap, only one well trip and resulting analyses is performed per well.

The objective of the groundwater monitoring plans (either previous or revised) is to examine the trend of the contaminants of concern to confirm that they are attenuating naturally. The overall concentration of uranium in network wells appears to be decreasing, but the concentration of cis-1,2-dichloroethene appears to be holding steady at levels above the drinking water standard (70 µg/L) in one well.

DOE will propose a change to the monitoring requirements with a permit modification in fiscal year 2004. The proposed change will bring the site under an integrated monitoring program with the 300-FF-5 Operable Unit.

B.11 Integrated Disposal Facility

The Integrated Disposal Facility will consist of a lined landfill covering 25 hectares located in the south-central part of the 200 East Area (Figure B.10). The landfill will be divided lengthwise into two distinct cells, one for the disposal of low-level radioactive waste and the other for the disposal of mixed waste. The facility will be a RCRA-compliant landfill (i.e., a double-lined trench with leachate collection system) that is ~442 meters wide by 555 meters in length by up to 15 meters deep. The landfill will contain four layers of waste containers separated vertically by 0.9 meter of soil. The approximate volume of waste to be deposited will be 100 hectare-meters. The waste will be segregated into a RCRA-permitted side and a non-RCRA-permitted side. Construction will begin in September 2004. Currently, the Part B Permit has been submitted to Ecology and is scheduled to be incorporated into the Hanford Facility RCRA Permit (Ecology 1994) in February 2004.

The groundwater monitoring network will consist of two upgradient wells and five downgradient wells (Table B.19). Three wells remain to be installed; two will be installed in the summer of fiscal year 2004, and the third will be installed at a future date when required by facility expansion. The indicator parameters that will be routinely monitored are listed in Table B.19.

The indicator parameters will be used to monitor for hazardous constituents reaching the groundwater as a result of Integrated Disposal Facility operations. Total organic carbon and total organic halides are indicator parameters selected to monitor the impact of RCRA-regulated organic constituents on groundwater quality. Specific conductance is selected as an indicator parameter to monitor the impact of metals and anions on groundwater quality. pH is a general indicator of groundwater quality. Chromium is included as an indicator parameter because hexavalent chromium is one of the more mobile of the regulated metals expected at the Integrated Disposal Facility and should be one of the first constituents to be detected in groundwater if the regulated facility affects groundwater.

Analyses of alkalinity, anions, and metals are to provide supplemental data on general groundwater chemistry beneath the Integrated Disposal Facility. This information aids data interpretation and quality control. Supplemental parameters will not be used in statistical evaluations. Turbidity is analyzed at the well just before sampling and provides an indication of the groundwater sample quality.

Monitoring will begin when all wells are ready to be sampled, currently anticipated for late fiscal year 2004. All indicator parameters will be monitored twice each quarter and supplemental parameters once each quarter to determine background concentrations. After the first year, indicator parameters will be monitored semiannually and supplemental parameters annually. In addition, field measurements of temperature and turbidity will be made at each sampling event.

During the first sampling event at each well, samples will be collected for analysis of the Appendix IX constituents (40 CFR 264) included in Chapter 1 of the Integrated Disposal Facility permit application.

B.12 Liquid Effluent Retention Facility

During fiscal year 2003, the Liquid Effluent Retention Facility was monitored by one upgradient and one downgradient well (Table B.20 and Figure B.11) because the other two downgradient wells failed to produce representative groundwater samples. Negotiations continue between Ecology, DOE, and contractors in an effort to formulate a final status monitoring strategy for the Liquid Effluent Retention Facility. In January 2001, Ecology directed DOE to suspend statistical evaluation of groundwater data at the facility.

B.13 Low-Level Waste Management Area 1

Groundwater monitoring under interim status requirements continued at this site in fiscal year 2003. The well network was sampled twice for groundwater contamination indicators and site-specific parameters (Table B.21 and Figure B.12). Downgradient monitoring well 299-E33-34 continued to exceed the critical mean for specific conductance during fiscal year 2003. This exceedance is related to the nitrate plume from the vicinity of the BY cribs and not Low-Level Waste Management Area 1.

Total organic carbon results were elevated in the June samples from several wells. The average of quadruplicate results for upgradient well 299-E32-4 (average 1,875 µg/L) and downgradient well 299-E33-34 (average 1,475 µg/L) exceeded the critical mean comparison value calculated from previous upgradient data. Elevated total organic carbon values have been reported from other sites including the 216-B-63 trench, Waste Management Area C and the Solid Waste Landfill. The exceedance is believed to be a laboratory problem that has since been resolved (see Appendix D). Upgradient/downgradient comparison values for fiscal year 2004 statistical evaluations are listed in Table B.22.

No wells in the network went dry in fiscal year 2003; thus, the monitoring network will remain the same in fiscal year 2004.

DOE submitted an application for a RCRA permit for all the burial grounds in fiscal year 2002 that included final status groundwater monitoring under WAC 173-303-645. Ecology reviewed the application and in fiscal year 2004, DOE will hold workshops with Ecology to resolve Ecology's notices of deficiency. Final status monitoring will begin following the effective date of the permit.

B.14 Low-Level Waste Management Area 2

This site continued in RCRA interim status indicator evaluation during fiscal year 2003. Wells were sampled twice for groundwater contamination indicators and site-specific parameters (Table B.23 and Figure B.6). Upgradient well 299-E34-7 continued to exceed the critical mean for specific conductance in fiscal year 2003. The major contributors to the increase are sulfate, chloride, and calcium. The source of these constituents is not known. This well also exceeded the critical mean values for total organic carbon and total organic halides in fiscal year 2003. Table B.24 lists the upgradient/downgradient comparison values for fiscal year 2004 statistical evaluations.

The monitoring network for Low-Level Waste Management Area 2 is distributed around the facility on all sides where an unconfined aquifer is present above the basalt surface. Thus, it is suitable for detecting releases from the facility. However, the continued decline in water level is causing additional wells to go dry. One well, 299-E34-3, went dry in late fiscal year 2002 and was not sampled during fiscal year 2003. Monitoring wells in this area are all completed at the top of basalt, so deeper wells are not an option for sampling the unconfined aquifer.

DOE submitted an application for a RCRA permit for all the burial grounds in fiscal year 2002 that included final status groundwater monitoring under WAC 173-303-645. Ecology reviewed the application and in fiscal year 2004, DOE will hold workshops with Ecology to resolve Ecology's notices of deficiency. Final status monitoring will begin following the effective date of the permit.

B.15 Low-Level Waste Management Area 3

This site continued in RCRA interim status indicator evaluation during fiscal year 2003. Wells were sampled twice for groundwater contamination indicators and site-specific parameters (Table B.25 and Figure B.13). Indicator parameter data of groundwater contamination from monitoring wells were statistically evaluated, and downgradient results remained less than the comparison values. Table B.26 lists upgradient/downgradient comparison values for fiscal year 2004 statistical evaluations.

Because of the changing direction of groundwater flow and the continuing decline in water levels, this network only marginally monitors this waste management area. All wells were successfully sampled in fiscal year 2003. Under current flow directions, wells 299-W10-19 and 299-W10-20 remain upgradient of the east portion of the waste management area but are downgradient of the southwest part of the waste management area. Ecology and DOE annually negotiate installation of future monitoring wells under Tri-Party Agreement (Ecology et al. 1998) Milestone M-24.

DOE submitted an application for a RCRA permit for all the burial grounds in fiscal year 2002 that included final status groundwater monitoring under WAC 173-303-645. Ecology reviewed the application and in fiscal year 2004, DOE will hold workshops with Ecology to resolve Ecology's notices of deficiency. Final status monitoring will begin following the effective date of the permit.

B.16 Low-Level Waste Management Area 4

Wells were sampled semiannually for contamination indicator parameters in accordance with RCRA interim status regulations (Table B.27 and Figure B.14). Downgradient well 299-15-16 continued to exceed the critical mean value for total organic halides in fiscal year 2003. This well was at one time an upgradient monitoring well and is still affected by contamination from other sources. DOE reported the exceedance to the U.S. Environmental Protection Agency (EPA) and Ecology in 1999. Upgradient/downgradient comparison values for fiscal year 2004 statistical evaluations are listed in Table B.28.

One monitoring well, 299-W18-24, went dry during fiscal year 2003. Only a partial sample was obtained in the first round of sampling from this well, and it was declared dry prior to the second semiannual sampling event. This monitoring network requires upgrading to satisfy RCRA requirements. There are currently two downgradient wells (including one deep well) and four upgradient wells (including one deep well). Ecology and DOE annually negotiate installation of future monitoring wells under Tri-Party Agreement (Ecology et al. 1998) Milestone M-24.

DOE submitted an application for a RCRA permit for all the burial grounds in fiscal year 2002 that included final status groundwater monitoring under WAC 173-303-645. Ecology reviewed the application and in fiscal year 2004, DOE will hold workshops with Ecology to resolve Ecology's notices of deficiency. Final status monitoring will begin following the effective date of the permit.

B.17 Nonradioactive Dangerous Waste Landfill

The Nonradioactive Dangerous Waste Landfill continued in an interim status, indicator parameter evaluation program during fiscal year 2003 (Table B.29 and Figure B.15). Statistical evaluations of groundwater contaminant indicator parameters indicate that the site has not adversely affected groundwater quality. The Nonradioactive Dangerous Waste Landfill groundwater monitoring plan (PNNL-12227) will have to be modified during fiscal year 2004 to remove well 699-26-35A as a background well. The well will not need to be replaced because there are two other background wells for this facility.

The two wells (699-25-33A and 699-26-35C) screened in the Ringold Formation lower permeability unit had reported values of pH above the background threshold range of 6.64 to 7.85. The highest reported pH value was 8.05. These two deeper wells are not used for upgradient/downgradient comparisons. Table B.30 lists upgradient/downgradient comparison values based on recent data for use in fiscal year 2004.

Sampling and analysis problems were not experienced in the Nonradioactive Dangerous Waste Landfill well network during fiscal year 2003, so there are no planned changes for fiscal year 2004.

B.18 PUREX Cribs

The 216-A-10, 216-A-36B, and 216-A-37-1 (PUREX) cribs continued to be monitored under a RCRA interim status groundwater quality assessment program in fiscal year 2003 (Table B.31 and Figure B.4). The cribs are monitored as a single waste management area because they have similar hydrogeology and waste constituents. The extent of contamination is discussed in Section 2.11.

Nitrate and manganese remain elevated above their drinking water standards (45 mg/L and 50 μg/L, respectively) in wells monitoring the PUREX cribs.

During fiscal year 2003, the water level in well 299-E17-9 dropped to a level where sampling is no longer possible. The well was replaced with well 299-E17-16. However, this substitute well is located southeast of well 299-E17-9 and does not intercept groundwater contamination plumes in a location where concentrations are as high as the 299-E17-9 well location. There are no other changes planned for fiscal year 2004. Flow rates for groundwater in the vicinity of the PUREX cribs are given in Table B.2.

B.19 Waste Management Area A-AX

Groundwater monitoring at A-AX Tank Farm continued under an interim status indicator evaluation program in fiscal year 2003. Wells were sampled twice for groundwater contamination indicators and site-specific parameters (Table B.32 and Figure B.16). Indicator parameter data from monitoring wells were statistically evaluated, and values from downgradient wells were compared to those established from the upgradient well. The indicator parameters (specific conductance, total organic carbon, and total organic halides) did not exceed critical mean values during fiscal year 2003. The pH value reported in downgradient well 299-E25-46 for the December 2002 sampling event was 6.81, which is below the critical range of 6.82 to 9.54. Verification sampling conducted in April 2003 showed this value was in error and that the correct pH value was 7.01. Table B.33 lists updated upgradient/downgradient comparison values for statistical evaluations in fiscal year 2004.

Table B.2 includes the general direction and an estimated rate of groundwater flow. The flow direction, determined using in situ flow measurements with the colloidal borescope and water elevations, is to the southeast. The saturated screen interval ranges from 1.8 to 3.8 meters thick in RCRA network wells while the aquifer thickness is ~27 meters. The average rate of water-table decline was 25 centimeters in 2003. If this rate continues, some of the RCRA-compliant wells at Waste Management Area A-AX will be dry in ~7 years. One new downgradient well, 299-E24-22, and one new upgradient well, 299-E25-93, were installed during fiscal year 2003 to increase the usefulness of the network to detect groundwater contamination associated with the tank farms. These wells are scheduled for sampling in December 2003.

B.20 Waste Management Area B-BX-BY

Groundwater quality assessment monitoring continued at this waste management area in fiscal year 2003. Assessment monitoring was initiated in 1996 when the critical mean value for specific conductance was exceeded in a downgradient well. Assessment wells were sampled quarterly, and in some cases, semiannually, in fiscal year 2003. Nitrate and cyanide exceeded drinking water standards in RCRA-compliant wells. Section 2.10 discusses plume extents and contaminant trends.

Originally, the RCRA groundwater monitoring network was designed for groundwater flow toward the northwest, based on regional plume maps. This method was used to determine flow direction because the water table is almost flat in the immediate area of the farms. Assessment studies have determined a southward flow direction across the site (Table B.2; Section 2.9.1 of PNNL-13404). Contaminant migration and results from colloidal borescope investigations indicate a south-to-southeast flow direction at the south boundary of the waste management area. Additional well installations have been planned to improve the coverage of the network.

In fiscal year 2003, the monitoring network included far-field wells (Table B.34 and Figure B.17). Some of these wells are RCRA-compliant, while others are older wells installed to monitor past-practice waste disposal sites. Water

levels in these wells remained unchanged during fiscal year 2003. Although the aquifer is ~1.7 meters thick in the north and will eventually go dry, it is >4 meters thick along the south border of the waste management area. Most of these wells can be used for at least 5 years. The new wells along the south boundary should be usable after the water table declines to a stable elevation.

B.21 Waste Management Area C

Interim-status, indicator-evaluation monitoring continued at this site in fiscal year 2003. Wells were sampled quarterly at the request of Ecology due to rising trends in sulfate, nitrate, and calcium currently detected in both upgradient and downgradient wells. In addition, the required detection sampling was conducted twice for indicator and site-specific parameters (Table B.35 and Figure B.18). Four new wells were installed to improve the capability of the detection network to determine if waste associated with the C Tank Farm is compromising groundwater quality.

The groundwater project revised the monitoring plan (PNNL-13024) for this site in 2002 (PNNL-13024-ICN-2). The revision accounts for the variable conditions in upgradient well 299-E27-7. A critical mean for specific conductance could not be calculated using data from this well because four quarters of stable data were not available. Consequently, upgradient/downgradient comparisons are deferred until specific conductance stabilizes or data from new upgradient well 299-E27-22 are available.

A general flow direction to the southwest has been established for this site using in situ flow measurements, plume tracking and water elevations corrected for borehole deviations from vertical. The monitoring network has been revised to reflect the change in interpretation (PNNL-13024-ICN-1). During fiscal year 2003, the site was monitored with the original configuration of wells. The four new monitoring wells, one upgradient and three downgradient, are scheduled to be sampled in December 2003. Preliminary sampling during the drilling of new upgradient well 299-E27-22 indicates very low levels of contamination. Consequently, four stable date points should be obtainable. Upgradient/downgradient comparisons should begin again in fiscal year 2005. A further discussion of chemical trends is provided in Section 2.10.

B.22 Waste Management Area S-SX

This site continued to be monitored under an interim status, groundwater quality assessment program during fiscal year 2003. DOE initiated the assessment program in response to a directive from Ecology in 1996. Monitoring wells sampled during the report period and constituents analyzed are listed in Table B.36, and the network configuration is shown in Figure B.19). The most recent revision of the monitoring plan (PNNL-12114) was issued in February 2002 (PNNL-12114-ICN-2). Nitrate and chromium, mobile tank farm contaminants regulated under RCRA, are elevated in downgradient wells. The highest concentrations in the network occur in well 299-W23-19 located adjacent to tank SX-115 in the southwest corner of the SX Tank Farm. This area appears to be the source of the downgradient occurrences of elevated nitrate. The moderately elevated carbon tetrachloride is attributed to past-practice upgradient sources (e.g., Plutonium Finishing Plant cribs, ditches, and trenches). The nearby upgradient crib, 216-S-25, was a major source of nitrate that passes beneath the south end of this waste management area. In addition, elevated but stable concentrations of mobile tank waste contaminants were observed in well 299-W22-48.

The rate and direction of groundwater flow (Table B.2) and the extent of contamination at Waste Management Area S-SX are discussed further in Section 2.9 of the main text.

B.23 Waste Management Area T

Waste Management Area T continued to be monitored under an interim status groundwater quality assessment program during fiscal year 2003 (Table B.37 and Figure B.20). The groundwater monitoring plan governing fiscal year 2003 groundwater activities at the waste management area is PNNL-12057, amended by PNNL-12057-ICN-1. One well is scheduled to be installed at the waste management area in calendar year 2004.

Evaluation of groundwater data in 2003 indicates that no RCRA-regulated, dangerous waste constituents from Waste Management Area T have affected groundwater. Chromium is found at concentrations greater than the drinking water standard of 100 µg/L at downgradient well 299-W11-41 (141 µg/L average 2003 concentration) and at downgradient well 299-W11-42 (132 µg/L average 2003 concentration). However, chromium concentrations in upgradient wells

299-W10-28 and 299-W10-4 were 105 and 327 μg/L, respectively (average annual concentrations). One or more of the upgradient cribs or trenches is the most likely source of elevated chromium in the area of Waste Management Area T.

The direction and rate of groundwater flow (Table B.2) are discussed in Section 2.8 of the main text.

B.24 Waste Management Area TX-TY

Waste Management Area TX-TY continued to be monitored under an interim status groundwater quality assessment program during fiscal year 2003 (Table B.38 and Figure B.20). The groundwater monitoring plan governing fiscal year 2003 groundwater activities at the waste management area is discussed in PNNL-12072, amended by PNNL-12072-ICN-1. One well is scheduled to be installed at the waste management area in calendar year 2004.

Evaluation of groundwater data in 2003 indicates that chromium occurs in concentrations greater than the drinking water standard (100 μg/L) at downgradient well 299-W14-13. The concentration of chromium in that well ranged between 427 and 540 μg/L in fiscal year 2003. There is some evidence suggesting that the chromium may be from the waste management area. However, nearby cribs also are possible sources for the chromium. Until an alternative source for chromium can be identified with some certainty, Waste Management Area TX-TY remains in groundwater quality assessment monitoring status.

The direction and rate of groundwater flow (Table B.2) are discussed in Section 2.8 of the main text.

B.25 Waste Management Area U

This unit was monitored under an interim status groundwater quality assessment program in fiscal year 2003 (Table B.39 and Figure B.19). The average specific conductance value in downgradient well 299-W19-41 exceeded the critical mean in August 1999, triggering assessment monitoring. Results of initial assessment studies (PNNL-13282) concluded that there is evidence that both upgradient sources and sources within the waste management area contributed to the elevated nitrate observed in monitoring wells. Thus, assessment monitoring will continue in accordance with the monitoring plan (PNNL-13612 and PNNL-13612-ICN-1).

The rate of groundwater flow is summarized in Table B.2 and the extent of contamination at this site is discussed in Section 2.9.

B.26 References

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Table B.1. RCRA Interim and Final Status Groundwater Monitoring, September 2003

TSD Unit or WMA	Monitoring Phase	Calendar Year into Site Permit (closing or operating)	Monitoring Plan and Comments
116-N-1 LWDF and 116-N-3 LWDF	Final status detection	1999 (closing)	BHI-00725. Closure plan states that during and after closure monitoring will continue under the interim status detection plan.
120-N-1 and 120-N-2 facilities	Final status detection	1999 (closing)	BHI-00725. Post-closure corrective action monitoring plan will be implemented following permit modification. RCRA corrective action decisions pending final record of decision for 100-NR-2 Operable Unit.
116-H-6 evaporation basins	Final status corrective action	1994 (closing)	PNNL-11573. Unit has contributed to chromium and nitrate contamination. RCRA monitoring continuing without statistical evaluation during period of 100-HR-3 operable unit's interim action for hexavalent chromium. RCRA corrective action decisions pending final record of decision for 100-HR-3 Operable Unit.
216-A-29 ditch	Interim status detection	2005 (closing)	PNNL-13047.
216-B-3 pond	Interim status detection	2003 (closing)	PNNL-13367. In 2-year trial period for alternative statistical technique; decision about post-closure monitoring is pending.
216-B-63 trench	Interim status detection	2005 (closing)	PNNL-14112.
216-S-10 pond and ditch	Interim status detection	2005 (closing)	PNNL-14070. Network comprises two downgradient wells and one upgradient well due to dropping water table.
216-U-12 crib	Interim status assessment	2005 (closing)	PNNL-14301. Crib has contributed to nitrate contamination. Network comprises two downgradient wells and no upgradient wells due to dropping water table.
316-5 process trenches	Final status corrective action	1996 (closing)	PNNL-13645. In 2-year trial period for alternative statistical technique. RCRA corrective action decisions pending final record of decision for 300-FF-5 Operable Unit.
IDF	Final status detection	Operating in 2004	New, proposed TSD. Permit application submitted in 2002; operation pending approval. Baseline groundwater monitoring will begin in 2004.
LERF	Final status detection suspended	1998 (operating)	WHC-SD-EN-AP-024. Unconfined aquifer disappearing as water table drops. Network comprises one downgradient well and one upgradient well. Washington State Department of Ecology directed DOE to cease statistical evaluations. Continuing to monitor available wells.
LLBGs (LLWMAs 1, 2, 3, and 4)	Interim status detection	2002 (operating)	WHC-SD-EN-AP-015. Permit application submitted in 2002; interim-status monitoring continues until approval of permit. Wells monitoring north part of LLWMA-2 are dry (5 of 16 original wells); 9 of 20 wells in original LLWMA-3 network are dry; current LLWMA-4 network comprises 2 downgradient wells and 4 upgradient wells (of the original 17 wells).
NRDWL	Interim status detection	2006 (closing)	PNNL-12227.
PUREX cribs (216-A-10, 216-A-36B, and 216-A-27-1)	Interim status assessment	TBD (closing)	PNNL-11523. Cribs have contributed to nitrate contamination.
SST WMA A-AX	Interim status detection	TBD (closing)	PNNL-13023.
SST WMA B-BX-BY	Interim status assessment	TBD (closing)	PNNL-13022. WMA has contributed to nitrate and nitrite contamination.

Table B.1. (contd)

TSD Unit or WMA	Monitoring Phase	Calendar Year into Site Permit (closing or operating)	Monitoring Plan and Comments
SST WMA C	Interim status detection	TBD (closing)	PNNL-13024.
SST WMA S-SX	Interim status assessment	TBD (closing)	PNNL-12114. WMA has contributed to chromium and nitrate contamination.
SST WMA T	Interim status assessment	TBD (closing)	PNNL-12057.
SST WMA TX-TY	Interim status assessment	TBD (closing)	PNNL-12072.
SST WMA U	Interim status assessment	TBD (closing)	PNNL-13612. WMA has contributed to nitrate contamination.

DOE = U.S. Department of Energy.
IDF = Integrated Disposal Facility.
LERF = Liquid effluent retention facility.
LLBG = Low-level burial ground.
LLWMA = Low-level waste management area.
LWDF = Liquid waste disposal facility.
NRDWL = Nonradioactive Dangerous Waste Landfill.
PUREX = Plutonium-Uranium Extraction (Plant).
RCRA = *Resource Conservation and Recovery Act*.
SST = Single-shell tank.
TBD = To be determined.
TSD = Treatment, storage, and disposal.
WMA = Waste management area.

Table B.2. Estimates of Groundwater Flow Rates at Hanford Site Facilities

Site	Flow Direction	Flow Rate (m/d)	Method	Hydraulic Conductivity (m/d) (source)	Effective Porosity[a]	Gradient[b]	Comments
116-N-1 LWDF	NW	0.08 to 1.4	Darcy	6.1 to 37 (PNL-8335)		0.0039	Gradient calculated between wells 199-N-66 and 199-N-2.
120-N-1 and 120-N-2	NW	0.05 to 0.9	Darcy	6.1 to 37 (PNL-8335)		0.0025	Gradient calculated between wells 199-N-72 and 199-N-26.
116-N-3 LWDF	N	0.05 to 0.84	Darcy	6.1 to 37 (PNL-8335)		0.0023	Gradient calculated between wells 199-N-28 and 199-N-81.
116-H-6 evaporation basins	E	0.18 to 4.9	Darcy	15 to 140 (PNL-6728)		0.0035	Gradient calculated between wells 199-H4-14 and 199-H4-3. Flow meter in wells 199-H4-7 and 199-H3-2A (Section 3.3 in DOE/RL-96-01).
200 Area TEDF	SW	0.003	Darcy	1.1 (WHC-SD-EN-ES-004)	0.25[c]	0.0006	Gradient calculated between wells 699-41-35 and 699-40-36.
216-A-29 ditch	WSW	~0.01 to ~0.04	Darcy	18 (WHC-SD-EN-DP-047)		~0.0002	
216-B-3 pond	SW	0.008	Darcy	1.0 (WHC-SD-EN-EV-002, PNL-10195)	0.25	0.002	Gradient calculated between wells 699-44-39B and 699-43-44.
216-B-63 trench	SW	0.03 to 0.4	Darcy	52 to 200 (WHC-SD-EN-EV-002)		~0.0002	
216-S-10 pond	ESE	0.007 to 0.30	Darcy	10 (WHC-SD-EN-DP-052) 12 to 150 (BNWL-1709)		0.0002	Wells are dry. Gradient calculated using regional water-table maps.
216-U-12 crib	ESE	0.008 to 0.01	Darcy	4.2 to 5.4 (PNNL-13378)		0.0002	Wells are dry. Gradient calculated using regional water-table maps.
316-5 process trenches	SE	10.7 (PNL-5408)	Movement of PCE spill				
	SE	0.35 to 105	Darcy	150 to 15,000 (PNL-6716)		0.0007	Normal river state (not high).
IDF	SE	0.002 to 0.0075	Darcy	68 to 75 (PNNL-13652, PNNL-11957)		0.00001	Uncertainty in gradient and rate of flow. Flow direction inferred from plume maps.
LERF	W	0.04 to 2.4	Darcy	6.1 to 120 (PNNL-11620)		0.002	

Table B.2. (contd)

Site	Flow Direction	Flow Rate (m/d)	Method	Hydraulic Conductivity (m/d) (source)	Effective Porosity[a]	Gradient[b]	Comments
LLWMA 1	NW	~0.01 to ~1.6	Darcy	73 to 760 (PNL-6820)		0.00006	Uncertainty with flow direction, rate, and gradient.
LLWMA 2	W to SW	~0.04 to ~0.6	Darcy	430 to 2,000 (PNL-6820)		~0.00003	Gradient calculated between wells 299-E34-10 and 299-E27-9. Uncertainty with flow direction, rate, and gradient.
LLWMA 3	70° E of N	0.0001 to 0.14	Darcy	0.02 to 9.8 (PNL-6820)		0.0014	Flow direction from trend-surface analysis.
LLWMA 4	E to ENE	0.2 to 0.7	Darcy	24 (PNL-6820)		0.003	Flow direction is variable due to effects of pump-and-treat system.
NRDWL	125° E of N (based on plume maps)	0.015 to 0.02	Darcy	518 to 1,524 (WHC-EP-0021)		0.00001	Uncertainty with gradient and rate of flow. Flow direction inferred from plume maps.
PUREX cribs	SE	0.3 to 0.0006	Darcy	18 to 3,000 (PNNL-11523)		0.00001	Uncertainty with gradient and rate of flow. Flow direction inferred from plume maps.
SWL	125° E of N (based on plume maps)	0.013 to 0.02	Darcy	640 to 1,280 (PNL-6820)		0.00001	Uncertainty with gradient and rate of flow. Flow direction inferred from plume maps.
WMA A-AX	SE	1.7 to 3.3	Darcy	1,981 to 2,519 (WHC-SD-EN-TI-019)	0.2 to 0.3	0.00026	
WMA B-BX-BY	WSW (north half) SSE to SE (south half)	0.8	Darcy	1,615 (WHC-SD-EN-TI-019)	0.3	0.00015	
WMA C	SW	1.2 to 2.3	Darcy	1,067 to 2,073 (WHC-SD-EN-TI-019)	0.3	0.00033	
WMA S-SX	E to ESE	0.07 to 0.14	Contaminant travel time (PNNL-13441)	NA	NA	NA	Based on inferred contaminant travel time between 216-S-25 crib and downgradient wells 299-W23-15 and 299-W22-46, and between wells 299-W22-46 and 299-W22-83.
		0.009 to 0.36	Darcy	0.58 to 17.2 (aquifer test data)	0.09 to 0.12	0.0018 to 0.0019	Based on aquifer tests (PNNL-13514 and PNNL-14113).

Table B.2. (contd)

Site	Flow Direction	Flow Rate (m/d)	Method	Hydraulic Conductivity (m/d) (source)	Effective Porosity[a]	Gradient[b]	Comments
WMA T	5°N of E to 8°E of S	0.003 to 0.024 0.022 to 0.029	Darcy Tracer tests	1 to 28 (PNNL-13378; PNNL-14113; PNNL-14186)	0.04 to 1.1	0.001	Flow direction based on trend surface analysis: PNNL-14113, PNNL-13378.
WMA TX-TY (north part)	18° E of S to 43° E of S	0.0007 to 2.46 0.122 to 1.1	Darcy Tracer test	0.05 to 4.9 (PNNL-13378; PNNL-14113; PNNL-14186)	0.002 to 1	0.001	Flow direction based on trend surface analysis: PNNL-14113, PNNL-13378, and PNNL-14186.
WMA TX-TY (south part)	South to southwest	0.29 0.374	Darcy Tracer test	14.2 to 19.9 (PNNL-13378; PNNL-14113; PNNL-14186)	0.068	0.001	Flow direction based on water-table evaluations; Flow rate and direction affected by 200-ZP-1 pump-and treat in south part of WMA. PNNL-13514.
WMA U	E	0.008 to 0.20	Darcy	1.2 to 9.5 (PNNL-13378)		0.0021	

(a) Effective porosity assumed to be between 0.1 and 0.3, a representative range for the unconfined aquifer system, unless otherwise noted.
(b) March 2003 unless noted otherwise.
(c) PNNL-11801.
IDF = Integrated Disposal Facility.
LERF = Liquid effluent retention facility.
LLWMA = Low-level waste management area.
LWDF = Liquid waste disposal facility.
NA = Not applicable.
NRDWL = Nonradioactive Dangerous Waste Landfill.
PCE = Tetrachloroethene.
PUREX = Plutonium-Uranium Extraction (Plant).
SWL = Solid Waste Landfill.
TEDF = Treated Effluent Disposal Facility.
WMA = Waste management area.

Table B.3. Wells Not Sampled as Scheduled for RCRA Facilities, Fiscal Year 2003

Well	Schedule	Site	Comments
199-N-59	03/01/03	120-N-1	Temporarily dry
199-N-59	09/01/03	120-N-1	Temporarily dry
299-E17-9	04/01/03	PUREX	Dry; one semiannual sample missed
299-E26-11	09/01/03	LERF	Change to semiannual in December and June
299-E34-3	10/01/02	LLBG (2)	Dry
299-E34-3	04/01/03	LLBG (2)	Dry
299-W10-13	03/01/03	LLBG (3)	Dry in fiscal year 2002
299-W10-13	09/01/03	LLBG (3)	Dry in fiscal year 2002
299-W10-27	02/01/03	WMA TX-TY	Pump problem; one quarter missed
299-W11-30	11/01/02	WMA T	Dry in fiscal year 2002
299-W11-30	05/01/03	WMA T	Dry in fiscal year 2002
299-W18-24	07/01/03	LLBG (4)	Dry; one semiannual sample missed
299-W7-8	03/01/03	LLBG (3)	Dry in fiscal year 2002
299-W7-8	09/01/03	LLBG (3)	Dry in fiscal year 2002

LERF = Liquid Effluent Retention Facility.
LLBG = Low-level burial ground.
PUREX = Plutonium-Uranium Extraction Plant.
WMA = Waste management area.

Table B.4. Monitoring Wells and Constituents for 100-N Area Units (adapted from PNNL-13914)

Well[a]	Hydrogeologic Unit Monitored
116-N-1 (1301-N) Liquid Waste Disposal Facility	
199-N-2 (P)	Top of unconfined
199-N-3 (P)	Top of unconfined
199-N-34 (P)	Top of unconfined
199-N-57	Top of unconfined
199-N-105A[b]	Unconfined
120-N-1 and 120-N-2 (1324-N/NA) Liquid Waste Disposal Facilities	
199-N-59	Top of unconfined
199-N-71	Top of unconfined
199-N-72	Top of unconfined
199-N-73	Top of unconfined
199-N-77[c]	Bottom of unconfined
116-N-3 (1325-N) Liquid Waste Disposal Facility	
199-N-28[c] (P)	Top of unconfined
199-N-32 (P)	Top of unconfined
199-N-41 (P)	Top of unconfined
199-N-74	Top of unconfined
199-N-81	Top of unconfined

Contamination Indicator Parameters	
pH (field)	Total organic carbon
Specific conductance (field)	Total organic halides
Site-Specific Parameters	
Alkalinity[d]	ICP metals (filtered)[d]
Anions[d]	Turbidity
AEA Parameters	
Gross alpha[e]	

(a) All wells constructed to WAC 173-160-400 standards unless noted (P), pre-RCRA. All wells sampled semiannually.
(b) Extraction well; screened over entire thickness of aquifer.
(c) Used for supplemental information; no statistical evaluations.
(d) Annually for 116-N-1 and 116-N-3 liquid waste disposal facilities.
(e) Gross alpha analyzed for wells 199-N-59 and 199-N-77 only.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act*.

Table B.5. Critical Means for 116-N-1 (1301-N) Liquid Waste Disposal Facility for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	8	7	5.4079	518	103.7	1,113	1,113
Field pH	8	7	6.0818	7.818	0.146	[6.88, 8.76]	[6.88, 8.76]
Total organic carbon,[b] µg/L	8	7	5.4079	421.35	379.330	2,597	2,600[c]
Total organic halides,[b] µg/L	8	7	5.4079	5.975	4.575	32.2	32.2

(a) Based on semiannual sampling events from March 2002 to September 2003 for upgradient wells 199-N-57 and 199-N-34.
(b) Critical means calculated from values reported below vendor's specified method detection limit.
(c) Rounded to the nearest tenth.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.

Table B.6. Critical Means for 120-N-1 and 120-N-2 (1324-N/NA) Liquid Waste Disposal Facilities for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	5	4	7.5288	366.2	14.9	489	489
Field pH	5	4	9.0294	8.138	0.045	[7.69, 8.58]	[7.69, 8.58]
Total organic carbon,[b] µg/L	5	4	7.5288	280.5	181.215	1,775	1,780[c]
Total organic halides,[b] µg/L	5	4	7.5288	6.385	2.226	24.7	24.7

(a) Based on semiannual sampling events from September 2001 to September 2003 for upgradient well 199-N-71.
(b) Critical means calculated from values reported below vendor's specified method detection limit.
(c) Rounded to the nearest tenth.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 12 comparisons.

Table B.7. Critical Means for 116-N-3 (1325-N) Liquid Waste Disposal Facility for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	5	4	8.1216	358.7	10.4	451	451
Field pH	5	4	9.7291	8.12	0.032	[7.78, 8.45]	[7.78, 8.45]
Total organic carbon,[b,c] µg/L	5	4	8.1216	179	94.515	1,020	1,360
Total organic halides, µg/L	5	4	8.1216	7.86	2.358	28.8	28.8

(a) Based on semiannual sampling events from September 2001 to September 2003 for upgradient well 199-N-74.
(b) Critical means calculated from values reported below vendor specified method detection limit.
(c) Upgradient/downgradient comparison value is the most recent determined limit of quantitation (see Table D.23).
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 16 comparisons.

Table B.8. Monitoring Wells and Constituents for the 116-H-6 (183-H) Evaporation Basins (adapted from PNNL-11573)

Well[a]	Hydrogeologic Unit Monitored
199-H4-3 (P)	Top of unconfined
199-H4-7[b]	Top of unconfined
199-H4-12A[b]	Top of unconfined
199-H4-12C	Mid-depth unconfined

Dangerous Waste Constituents	
Chromium (filtered)	Nitrate
Fluoride	
Site-Specific Parameters	
Alkalinity	pH
Anions	Specific conductance
ICP metals (filtered)	Turbidity
Other Parameters[c]	
Technetium-99	Uranium

(a) All wells constructed to WAC 173-160-400 standards unless noted (P), pre-RCRA. All wells are sampled annually.
(b) Also a CERCLA extraction well.
(c) Radionuclides not typically subject to RCRA monitoring, but included in the current Hanford Facility RCRA Permit (Ecology 1994) for this facility.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act.*
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act.*

Table B.9. Monitoring Wells and Constituents for the 216-A-29 Ditch (adapted from PNNL-13047)

Well[a]	Hydrogeologic Unit Monitored
299-E25-26	Upper unconfined
299-E25-28[b]	Deep unconfined
299-E25-32P	Top of unconfined
299-E25-34	Top of unconfined
299-E25-35	Top of unconfined
299-E25-48	Top of unconfined
299-E26-12	Top of unconfined
299-E26-13	Top of unconfined
699-43-45	Top of unconfined

Contamination Indicator Parameters	
pH (field)	Total organic carbon
Specific conductance (field)	Total organic halides
Site-Specific Parameters	
Alkalinity	Phenols
Anions	Turbidity
ICP metals (filtered)[c]	

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled quarterly.
(b) Used for supplemental information; no statistical evaluations.
(c) Analyzed annually.
Bold italic = Upgradient wells.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.10. Critical Means for the 216-A-29 Ditch for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	4	3	15.145	236.2	2.0	271	271
Field pH	4	3	19.118	8.349	0.036	[7.59, 9.11]	[7.59, 9.11]
Total organic carbon, µg/L	4	3	15.145	289.38	142.235	2,698	2,700[c]
Total organic halides,[b,d] µg/L	4	3	15.145	NC	NC	NC	14.9

(a) Based on semiannual sampling events from April 2002 to April 2003 for upgradient well 699-43-45.
(b) Critical mean cannot be calculated because essentially all measurements are below vendor's specified method detection limit.
(c) Rounded to the nearest tenth.
(d) Upgradient/downgradient comparison value is the most recent determined limit of quantitation (see Table D.23).
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
NC = Not calculated.
t_c = Bonferroni critical t-value for appropriate df and 32 comparisons.

Table B.11. Monitoring Wells and Constituents for the 216-B-3 Pond (adapted from PNNL-13367-ICN-1)

Well[a]	Hydrogeologic Unit Monitored	Site-Specific Indicator Parameters	
699-42-42B	Top of uppermost	Gross alpha	Specific conductance (field)
699-43-44	Bottom of uppermost	Gross beta	
699-43-45	Top of uppermost	Site-Specific Parameters	
699-44-39B	Top of uppermost	Anions[b]	Nitrate[c]
		Arsenic[c]	Phenols[b]
		Metals (filtered, unfiltered)[b,d]	Tritium[c]
		Iodine-129[c]	Turbidity

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled semiannually.
(b) Analyzed annually.
(c) Constituents of site-wide concern; selected wells analyzed under AEA monitoring.
(d) ICP plus cadmium, lead, mercury, and silver.
Bold italic = Upgradient well.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.12. Critical Means for the 216-B-3 Pond for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	5	4	8.1216	260.4	9.5	345	345
Field pH	5	4	9.7291	8.14	0.051	[7.60, 8.68]	[7.60, 8.68]
Total organic carbon, µg/L	5	4	8.1216	598.15	301.433	3,280	3,280
Total organic halides,[b] µg/L	5	4	8.1216	NC	NC	NC	14.9

(a) Based on semiannual sampling events from June 1999 to June 2001 for upgradient well 699-44-39B. Background levels will be revised when four quarters of data are available in 2004.
(b) Critical mean cannot be calculated because essentially all measurements are below vendor's specified method detection limit. Upgradient/downgradient comparison value is the most recent determined limit of quantitation (see Table D.23).
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
NC = Not calculated.
t_c = Bonferroni critical t-value for appropriate df and 16 comparisons.

Table B.13. Monitoring Wells and Constituents for the 216-B-63 Trench (adapted from PNNL-14112)

Well[a]	Hydrogeologic Unit Monitored	Contamination Indicator Parameters	
299-E27-8	Top of unconfined	pH (field)	Total organic carbon
299-E27-9	Top of unconfined	Specific conductance (field)	Total organic halides
299-E27-11	Top of unconfined		
299-E27-16	Top of unconfined	Site-Specific Parameters	
299-E27-17	Top of unconfined	Alkalinity[b]	Phenols[b]
299-E27-18	Top of unconfined	Anions[b]	Turbidity
299-E27-19	Top of unconfined	ICP metals (filtered)[b]	
299-E33-33	Top of unconfined		
299-E33-36	Top of unconfined	AEA Parameters[c]	
299-E33-37	Top of unconfined	Gross alpha	Gross beta
299-E34-8	Top of unconfined		
299-E34-10	Top of unconfined		

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled semiannually.
(b) Analyzed annually.
(c) Analyzed to support AEA monitoring.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.14. Critical Means for the 216-B-63 Trench for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	20	19	4.267	416.9	28.5	541	541
Field pH	20	19	4.572	8.063	0.064	[7.76, 8.36]	[7.76, 8.36]
Total organic carbon,[b] µg/L	20	19	4.267	288.375	187.587	1,109	1,360
Total organic halides,[b,c] µg/L	20	19	4.267	NC	NC	NC	14.9

(a) Based on semiannual sampling events from October 2001 to April 2003 for upgradient wells 299-E27-8, 299-E27-9, 299-E27-11, 299-E27-17, and 299-E34-10.
(b) Upgradient/downgradient comparison value is the most recently determined limit of quantitation (see Table D.23).
(c) Critical mean cannot be calculated because essentially all measurements are below vendor's specified method detection limit.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
NC = Not calculated.
t_c = Bonferroni critical t-value for appropriate df and 48 comparisons.

Table B.15. Monitoring Wells and Constituents for the 216-S-10 Pond and Ditch (adapted from PNNL-14070)

Well[a]	Hydrogeologic Unit Monitored	Contamination Indicator Parameters	
299-W26-7	Top of unconfined	pH (field)	Specific conductance (field)
299-W26-13	Top of unconfined	Total organic carbon[b]	Total organic halides[b]
299-W26-14	Top of unconfined		
299-W27-2[c]	Base of unconfined	Site-Specific Parameters	
		Alkalinity[d]	ICP metals (filtered)[d]
		Anions[d]	Phenols[b,d]
		Hexavalent chromium (filtered)[e]	Turbidity[e]
			Volatile organic compounds[e]

(a) All wells constructed to WAC 173-160-400 standards and sampled semiannually. Well 299-W26-7 went dry after fiscal year 2003 sampling.
(b) Not analyzed in well 299-W27-2.
(c) Used for supplemental information; no statistical evaluation.
(d) Analyzed annually only.
(e) Analyzed semiannually.
Bold italic = Upgradient wells.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.16. Critical Means for the 216-S-10 Pond and Ditch for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	4	3	10.8689	269.8	2.2	296	296
Field pH	4	3	13.745	8.109	0.041	[7.49, 8.73]	[7.49, 8.73]
Total organic carbon,[b,c] µg/L	4	3	10.8689	195.625	90.884	1,300	1,360
Total organic halides,[c,d] µg/L	4	3	10.8689	NC	NC	NC	14.9

(a) Based on semiannual sampling events from December 2001 to June 2003 for upgradient well 299-W26-7, which went dry in 2003. Background levels will be revised when data from a new upgradient well are available.
(b) Critical mean calculated from values reported below vendor's specified method detection limit.
(c) Upgradient/downgradient comparison value is the most recently determined limit of quantitation (see Table D.23).
(d) Critical mean cannot be calculated because essentially all measurements are below vendor specified detection limit.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
NC = Not calculated.
t_c = Bonferroni critical t-value for appropriate df and 12 comparisons.

Table B.17. Monitoring Wells and Constituents for the 216-U-12 Crib (adapted from WHC-SD-EN-AP-108 and PNNL-14301)

Well[a]	Hydrogeologic Unit Monitored
299-W22-79	Top of unconfined
699-36-70A	Top of unconfined

Contamination Indicator Parameters	
pH (field)	Specific conductance (field)
Site-Specific Parameters	
Alkalinity[b,c]	Total dissolved solids[b,d]
Anions	Turbidity
ICP metals (filtered)[b]	
AEA Parameters[c]	
Iodine-129[e]	Technetium-99[e]

(a) Both wells constructed to WAC 173-160-400 standards and sampled quarterly.
(b) Analyzed annually.
(c) Analyzed to support AEA monitoring.
(d) Well 699-36-70A only.
(e) Analyzed semiannually.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.18. Monitoring Wells and Constituents for the 316-5 Process Trenches

Adapted from PNNL-13645	
Well[a]	Hydrogeologic Unit Monitored
399-1-7	Top of unconfined
399-1-8 (S)	Bottom of unconfined
399-1-10A	Top of unconfined
399-1-10B (S)	Bottom of unconfined
399-1-11	Top of unconfined
399-1-16A	Top of unconfined
399-1-16B	Bottom of unconfined
399-1-17A	Top of unconfined
399-1-17B (S)	Bottom of unconfined
399-1-21A (S)	Top of unconfined
399-1-21B (S)	Bottom of unconfined

Adapted from WHC-SD-EN-AP-185	
Well[b]	Hydrogeologic Unit Monitored
399-1-10A	Top of unconfined
399-1-10B	Bottom of unconfined
399-1-16A	Top of unconfined
399-1-16B	Bottom of unconfined
399-1-17A	Top of unconfined
399-1-17B	Bottom of unconfined
399-1-18A	Top of unconfined
399-1-18B	Bottom of unconfined

Field-Measured Parameters	
pH	Turbidity
Specific conductance	
AEA Parameters	
Uranium	

Site-Specific Parameters	
cis-1,2-dichloroethene	Trichloroethene
Tetrachloroethene	

(a) All wells constructed to WAC 173-160-400 standards. Wells sampled quarterly unless noted (S), semiannually.
(b) All wells constructed to WAC 173-160-400 standards. All wells sampled for four consecutive months, twice per year (semiannually).
AEA = *Atomic Energy Act of 1954*.

Table B.19. Monitoring Wells and Constituents for the Integrated Disposal Facility (adapted from DOE/RL-2003-12)

Well[a]	Contaminants of Concern[b]
299-E17-22	40 CFR 264, Appendix IX
299-E17-23	
299-E17-25	
299-E24-21	
Proposed downgradient well 1	
Proposed downgradient well 2	
Proposed upgradient well 3	

Indicator Parameters[c]	
Chromium (filtered)	Total organic carbon
pH	Total organic halides
Specific conductance (field)	

Supplemental Parameters[d]	
Alkalinity	ICP metals
Anions	Turbidity (field)

(a) All wells constructed to WAC 173-160-400 standards. All wells completed at the top of the unconfined aquifer. One upgradient well and one downgradient well scheduled for installation in late fiscal year 2004. The second downgradient well is proposed for an unspecified time in the future.
(b) Sampled one time per well.
(c) Sampled two times per quarter for 1 year to establish background, then four times semiannually (total of eight samples per well per year) thereafter.
(d) Sampled semiannually.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.20. Monitoring Wells and Constituents for the Liquid Effluent Retention Facility (adapted from WHC-SD-EN-AP-024)

Well[a]	Hydrogeologic Unit Monitored	Contamination Indicator Parameters[b]	
299-E26-10 (S)	Top of unconfined	pH (field)	Total organic carbon
299-E26-11 (Q)	Top of unconfined	Specific conductance (field)	Total organic halides

Site-Specific Parameters	
Alkalinity[c]	Phenols[c]
Ammonium[c]	Temperature
Anions[c]	Turbidity
ICP metals (filtered)[c]	Volatile organic compounds

AEA Parameters[d]	
Gross alpha[c]	Gross beta[c]

(a) Both wells constructed to WAC-160-400 standards. Both wells sampled quarterly.
(b) Statistical evaluations suspended in January 2001 because only one downgradient well is not dry.
(c) Analyzed annually.
(d) Analyzed to support AEA monitoring.
Bold italic = Upgradient well.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
(Q) = Sampled quarterly.
(S) = Sampled semiannually.

Table B.21. Monitoring Wells and Constituents for Low-Level Waste Management Area 1 (adapted from WHC-SD-EN-AP-015)

Well[a]	Hydrogeologic Unit Monitored	RCRA Contamination Indicator Parameters	
299-E28-26	Top of unconfined	pH (field)	Total organic carbon
299-E28-27	Top of unconfined	Specific conductance (field)	Total organic halides
299-E28-28	Top of unconfined		
299-E32-2	Top of unconfined	**RCRA Site-Specific Parameters**	
299-E32-3	Top of unconfined	Alkalinity	Mercury (filtered)
299-E32-4	Top of unconfined	Anions	Phenols[b]
299-E32-5	Top of unconfined	ICP metals (filtered)	Turbidity
299-E32-6	Top of unconfined	Lead (filtered)	
299-E32-7	Top of unconfined		
299-E32-8	Top of unconfined	**AEA Parameters[c]**	
299-E32-9	Top of unconfined	Gross alpha	Tritium
299-E32-10	Top of unconfined	Gross beta	Uranium
299-E33-28	Top of unconfined	Technetium-99[d]	
299-E33-29	Top of unconfined		
299-E33-30	Top of unconfined		
299-E33-34	Top of unconfined		
299-E33-35	Top of unconfined		

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled semiannually.
(b) Analyzed annually.
(c) Analyzed to support AEA monitoring.
(d) Performance assessment parameter.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.22. Critical Means for Low-Level Waste Management Area 1 for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	28	27	4.1542	477.8	49.4	687	687
Field pH	28	27	4.4138	8.020	0.110	[7.53, 8.51]	[7.53, 8.51]
Total organic carbon,[b] µg/L	25[c]	24	4.2304	410.55	162.641	1,112	1,360
Total organic halides,[b,d] µg/L	28	27	4.1542	NC	NC	NC	14.9

(a) Based on semiannual sampling events from December 2001 to June 2002 for upgradient wells 299-E28-26, 299-E28-27, 299-E28-28, 299-E32-4, 299-E33-28, 299-E33-29, and 299-E33-35.
(b) Upgradient/downgradient comparison value is the most recently determined limit of quantitation (see Table D.23).
(c) Excluded suspected total organic carbon values analyzed in June 2003 from wells 299-E28-27, 299-E32-4, and 299-E33-28.
(d) Critical mean cannot be calculated because essentially all of the measurements are below vendor's specified method detection limit.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
NC = Not calculated.
t_c = Bonferroni critical t-value for appropriate df and 68 comparisons.

Table B.23. Monitoring Wells and Constituents for Low-Level Waste Management Area 2 (adapted from WHC-SD-EN-AP-015)

Well[a]	Hydrogeologic Unit Monitored
299-E27-8	Top of unconfined
299-E27-9	Top of unconfined
299-E27-10	Top of unconfined
299-E27-11	Top of unconfined
299-E27-17	Top of unconfined
299-E34-2[b]	Top of unconfined
299-E34-5[d]	Top of unconfined
299-E34-7	Top of unconfined
299-E34-9	Top of unconfined
299-E34-10	Top of unconfined
299-E34-12	Top of unconfined

RCRA Contamination Indicator Parameters	
pH (field)	Total organic carbon
Specific conductance (field)	Total organic halides

RCRA Site-Specific Parameters	
Alkalinity	Mercury (filtered)
Anions	Phenols[c]
ICP metals (filtered)	Polychlorinated biphenyls
Lead (filtered)	Turbidity

AEA Parameters[e]	
Gross alpha	Technetium-99[f]
Gross beta	Tritium
Iodine-129[f]	Uranium[f]

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled semiannually.
(b) This well went dry during fiscal year 2003 after sampling was completed.
(c) Analyzed annually.
(d) Used for supplemental information; no statistical evaluation.
(e) Analyzed to support AEA monitoring.
(f) Performance assessment parameters.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act*.

Table B.24. Critical Means for Low-Level Waste Management Area 2 for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	6	5	7.9757	714.1	83.2	1,431	1,431
Field pH	6	5	9.2355	7.995	0.095	[7.05, 8.94]	[7.05, 8.94]
Total organic carbon, µg/L	6	5	7.9757	699.17	321.328	3,467	3,470[b]
Total organic halides,[c,d] µg/L	6	5	7.9757	3.306	1.284	14.4	14.9

(a) Based on semiannual sampling events from April 2000 to April 2003 for upgradient well 299-E27-10. Data from well 299-E34-7 are excluded due to elevated levels of all indicator parameters.
(b) Rounded to the nearest tenth.
(c) Critical mean calculated from values below vendor's specified method detection limit.
(d) Upgradient/downgradient comparison value is the most recently determined limit of quantitation (see Table D.23).
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 40 comparisons.

Table B.25. Monitoring Wells and Constituents for Low-Level Waste Management Area 3 (adapted from WHC-SD-EN-AP-015)

Well[a]	Hydrogeologic Unit Monitored
299-W7-1	Top of unconfined
299-W7-3[b]	Deep unconfined
299-W7-4	Top of unconfined
299-W7-5	Top of unconfined
299-W7-7	Top of unconfined
299-W7-12	Top of unconfined
299-W8-1	Top of unconfined
299-W10-14[b]	Deep unconfined
299-W10-19	Top of unconfined
299-W10-20	Top of unconfined
299-W10-21	Top of unconfined

RCRA Contamination Indicator Parameters	
pH (field)	Total organic carbon
Specific conductance (field)	Total organic halides

RCRA Site-Specific Parameters	
Alkalinity	Mercury (filtered)
Anions	Phenols
ICP metals (filtered)	Volatile organic compounds
Lead (filtered)	

AEA Parameters[c]	
Gross alpha	Tritium
Gross beta	Turbidity
Iodine-129[d]	Uranium[d]
Technetium-99[d]	

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled semiannually.
(b) Used for supplemental information; no statistical evaluations.
(c) Analyzed to support AEA monitoring.
(d) Performance assessment parameters.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act*.

Table B.26. Critical Means for Low-Level Waste Management Area 3 for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	12	11	4.7979	479.6	55.9	758	758
Field pH	12	11	5.2381	8.125	0.196	[7.05, 9.20]	[7.05, 9.20]
Total organic carbon,[b] µg/L	12	11	4.7979	310.42	211.267	1,365	1,370[c]
Total organic halides, µg/L	12	11	4.7979	162.048	160.990	966	966

(a) Based on semiannual sampling events from March 2002 to September 2003 for upgradient wells 299-W10-19, 299-W10-20, and 299-W10-21.
(b) Critical mean calculated from values below vendor's specified method detection limit.
(c) Rounded to the nearest tenth.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 36 comparisons.

Table B.27. Monitoring Wells and Constituents for Low-Level Waste Management Area 4 (adapted from WHC-SD-EN-AP-015)

Well[a]	Hydrogeologic Unit Monitored
299-W15-15	Top of unconfined
299-W15-16	Top of unconfined
299-W15-17[b]	Deep unconfined
299-W18-21	Top of unconfined
299-W18-22[b]	Deep unconfined
299-W18-23	Top of unconfined
299-W18-24[c]	Top of unconfined

RCRA Contamination Indicator Parameters	
pH (field)	Total organic carbon
Specific conductance (field)	Total organic halides

RCRA Site-Specific Parameters	
Alkalinity	Mercury (filtered)
Anions	Phenols
ICP metals (filtered)	Turbidity
Lead (filtered)	Volatile organic compounds

AEA Constituents[d]	
Gross alpha	Technetium-99
Gross beta	Tritium
Iodine-129	

Performance Assessment Parameters
Uranium

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled semiannually.
(b) Used for supplemental information; no statistical evaluations.
(c) This well went dry in fiscal year 2003; only a partial sample was obtained for the first semiannual event.
(d) Analyzed to support AEA monitoring.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act*.

Table B.28. Critical Means for Low-Level Waste Management Area 4 for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	12	11	4.3034	470.1	86.5	858	858
Field pH	12	11	4.7248	7.941	0.099	[7.46, 8.43]	[7.46, 8.43]
Total organic carbon, µg/L	10[b]	9	4.6231	432.75	290.938	1,843	1,840[c]
Total organic halides, µg/L	12	11	4.3034	26.112	21.696	123.3	123.3

(a) Based on semiannual sampling events from January 2002 to July 2003 for upgradient wells 299-W15-15, 299-W18-21, and 299-W18-23.
(b) Excluded suspected total organic carbon values analyzed in July 2003 from wells 299-W15-15 and 299-W18-21.
(c) Rounded to the nearest tenth.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 16 comparisons.

Table B.29. Monitoring Wells and Constituents for the Nonradioactive Dangerous Waste Landfill (adapted from PNNL-12227)

Well[a]	Hydrogeologic Unit Monitored	Contamination Indicator Parameters	
699-25-33A[b]	Top of LPU[c]	pH (field)	Total organic carbon
699-25-34A	Top of unconfined	Specific conductance (field)	Total organic halides
699-25-34B	Top of unconfined		
699-25-34D	Top of unconfined	Site-Specific Parameters	
699-26-33	Top of unconfined	Anions	Turbidity
699-26-34A	Top of unconfined	ICP metals (filtered)	Volatile chlorinated
699-26-34B	Top of unconfined	Phenols[d]	hydrocarbons
699-26-35A	Top of unconfined		
699-26-35C[b]	Top of LPU[c]		

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled semiannually.
(b) Used for supplemental information; no statistical evaluation.
(c) Low-permeability unit (LPU) in upper Ringold Formation.
(d) Analyzed annually.
Bold italic = Upgradient wells.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.30. Critical Means for Nonradioactive Dangerous Waste Landfill for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	5	4	9.0293	536.6	16.0	695	695
Field pH	5	4	10.802	7.226	0.070	[6.40, 8.05]	[6.40, 8.05]
Total organic carbon,[b] µg/L	5	4	9.0293	211.5	175.692	1,949	1,950[c]
Total organic halides,[b] µg/L	5	4	9.0293	3.06	1.337	16.3	16.3

(a) Based on most recent sampling events from February 2001 to September 2003 for upgradient well 699-26-34A.
(b) Critical mean calculated from values reported below vendor's specified method detection limit.
(c) Rounded to the nearest tenth.
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 24 comparisons.

Table B.31. Monitoring Wells and Constituents for PUREX Cribs 216-A-10, 216-A-36B, and 216-A-37-1 (adapted from PNNL-11523)

Well[a]	Hydrogeologic Unit Monitored	Contamination Indicator Parameters	
Upgradient Wells		pH (field)[b]	Specific conductance (field)[b]
299-E24-18	Top of unconfined		
299-E25-31	Top of unconfined	Site-Specific Parameters	
Near-Field Wells – 216-A-10 Crib		Alkalinity	ICP metals (filtered)
299-E17-1 (P)	Top of unconfined	Ammonium ion	Phenols
299-E17-19	Top of unconfined	Anions[b]	Turbidity[b]
299-E24-16 (Q)	Top of unconfined	Arsenic (filtered)	
Near-Field Wells – 216-A-36B Crib		AEA Parameters[c]		
299-E17-14 (Q)	Top of unconfined	Gross alpha	Iodine-129[b]	Tritium[b]
299-E17-16	Top of unconfined	Gross beta	Strontium-90	
299-E17-18	Top of unconfined			
Near-Field Wells – 216-A-37-1 Crib				
299-E25-17 (P)	Top of unconfined			
299-E25-19 (P,Q)	Top of unconfined			
699-37-47A	Top of unconfined			
Far-Field Wells[d]				
57 wells	Unconfined			

(a) Wells constructed to WAC 173-160-400 standards unless noted (P), pre-RCRA. Wells sampled semiannually unless noted (Q), quarterly.
(b) Far-field wells analyzed for these constituents only.
(c) Analyzed to support AEA monitoring.
(d) Far-field wells sampled annually to triennially.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
PUREX = Plutonium-Uranium Extraction (Plant).
RCRA = *Resource Conservation and Recovery Act*.

Table B.32. Monitoring Wells and Constituents for Waste Management Area A-AX (adapted from PNNL-13023-ICN-1)

Well[a]	Hydrogeologic Unit Monitored
299-E24-19	Top of unconfined
299-E24-20	Top of unconfined
299-E24-22[b]	Top of confined
299-E25-40[c]	Top of unconfined
299-E25-41	Top of unconfined
299-E25-46	Top of unconfined
299-E25-93[b]	Top of confined

Contamination Indicator Parameters	
pH (field)	Total organic carbon
Specific conductance (field)	Total organic halides
Site-Specific Parameters	
Alkalinity	ICP metals (filtered)
Anions	Phenols[d]
AEA Parameters[e]	
Gross beta[d]	Technetium-99[d]
Gross gamma[d]	Tritium[d]
Iodine-129[d]	Uranium[d]
Strontium-90[d]	

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled semiannually.
(b) New well constructed in fiscal year 2003. First samples scheduled for December 2003.
(c) Information only; not used in statistical evaluations.
(d) Annually.
(e) Analyzed to support AEA monitoring.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.33. Critical Means for Waste Management Area A-AX for Fiscal Year 2004 Comparisons[a]

Constituent, unit	n	df	t_c	Average Background	Standard Deviation	Critical Mean	Upgradient/ Downgradient Comparison Value
Specific conductance, µS/cm	5	4	8.6103	369.2	29.5	647	647
Field pH	5	4	10.3063	8.136	0.073	[7.31, 8.96]	[7.31, 8.96]
Total organic carbon, µg/L	4[b]	3	12.9240	531.25	126.697	2,362	2,360[c]
Total organic halides,[d] µg/L	5	4	8.6103	NC	NC	NC	14.9

(a) Based on semiannual sampling events from July 2001 to June 2003 for upgradient well 299-24-20. Background levels will be revised when data from new upgradient wells are available.
(b) Excluded suspected total organic carbon values analyzed in June 2003 from well 299-E24-20.
(c) Rounded to the nearest tenth.
(d) Critical mean cannot be calculated because essentially all measurements are below vendor's specified method detection limit. Upgradient/downgradient comparison value is the most recently determined limit of quantitation (see Table D.23).
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
NC = Not calculated.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.

Table B.34. Monitoring Wells and Constituents for Waste Management Area B-BX-BY (adapted from PNNL-13022)

Well[a]	Contamination Indicator Parameters	
Near-Field Wells	pH	Total organic carbon
299-E28-8[b] (P)	Specific conductance	
299-E33-7 (P)		
299-E33-9[b] (P)	**Site-Specific Parameters**	
299-E33-10[b] (P)	Alkalinity	ICP metals (filtered)
299-E33-15[b] (P)	Anions	Turbidity
299-E33-16[b] (P)	Cyanide	
299-E33-17[b] (P)		
299-E33-18 (P)	**AEA Parameters[c]**	
299-E33-20[b] (P)	Gross alpha	Technetium-99
299-E33-21[b] (P)	Gross beta	Tritium
299-E33-31	Low-level gamma (cobalt-60, cesium-137)	Uranium
299-E33-32		
299-E33-38		
299-E33-39		
299-E33-41		
299-E33-42		
299-E33-43		
299-E33-44		
299-E33-334		
299-E33-335		
299-E33-337		
299-E33-338		
299-E33-339		
Far-Field Wells		
299-E33-26		
299-E33-28		
299-E33-29		

(a) All wells constructed to WAC 173-160-400 standards unless noted (P), pre-RCRA, and are completed in the unconfined aquifer. Wells sampled quarterly.
(b) Sampled to support RCRA assessment.
(c) Analyzed to support AEA monitoring.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act*.

Table B.35. Monitoring Wells and Constituents for Waste Management Area C (adapted from PNNL-13024-ICN-1)

Well[a]	Contamination Indicator Parameters	
299-E27-4[b]	pH (field)	Total organic carbon
299-E27-7[c] (P)	Specific conductance (field)	Total organic halides
299-E27-12		
299-E27-13	Site-Specific Parameters	
299-E27-14	Alkalinity	ICP metals (filtered)
299-E27-15[c]	Anions	Phenols
299-E27-21[b]	Cyanide	Turbidity
299-E27-22[b]		
299-E27-23[b]	AEA Parameters[d]	
	Gamma scan	Technetium-99
	Gross beta	Total uranium

(a) All wells constructed to WAC 173-160-400 standards unless noted (P), pre-RCRA. All wells completed at the top of the unconfined aquifer. All wells sampled semiannually.
(b) New well constructed in fiscal year 2003. First sampling scheduled for December 2003.
(c) Used for supplemental information; no statistical evaluation.
(d) Analyzed to support AEA monitoring.

Bold italic = Upgradient well.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act*.

Table B.36. Monitoring Wells and Constituents for Waste Management Area S-SX (adapted from PNNL-12114-ICN-1)

Well[a]	Hydrogeologic Unit Monitored	Contamination Indicator Parameters	
299-W22-44	Top of unconfined	pH (field)	Specific conductance (field)
299-W22-45	Top of unconfined		
299-W22-46	Top of unconfined	Site-Specific Parameters	
299-W22-48	Top of unconfined	Alkalinity	ICP metals (filtered)
299-W22-49	Top of unconfined	Anions	Turbidity
299-W22-50	Top of unconfined		
299-W22-80	Top of unconfined	AEA Parameters[b]	
299-W22-81	Top of unconfined	Gamma scan	Technetium-99
299-W22-82	Top of unconfined	(cesium-137)[c]	Tritium
299-W22-83	Top of unconfined	Gross beta[d]	Uranium
299-W22-84	Top of unconfined		
299-W22-85	Top of unconfined		
299-W23-15	Top of unconfined		
299-W23-19	Top of unconfined		
299-W23-20	Top of unconfined		
299-W23-21	Top of unconfined		

(a) All wells constructed to WAC 173-160-400 standards. All wells sampled quarterly, except for certain constituents as noted.
(b) Analyzed to support AEA monitoring.
(c) Analysis done only on well 299-W23-19 annually.
(d) Analysis done only on well 299-W23-19 quarterly.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.

Table B.37. Monitoring Wells and Constituents for Waste Management Area T (adapted from PNNL-12057-ICN-1)

Well[a]	Hydrogeologic Unit Monitored	Contamination Indicator Parameters	
299-W10-1 (P)	Top of unconfined	pH (field)	Specific conductance (field)
299-W10-4 (P)	Top of unconfined		
299-W10-8 (P)	Top of unconfined	Site-Specific Parameters[b]	
299-W10-22 (S)	Top of unconfined	Alkalinity	ICP metals (filtered)
299-W10-23	Top of unconfined	Anions	Turbidity (field)
299-W10-24	Top of unconfined		
299-W10-28	Top of unconfined	AEA Parameters[c]	
299-W11-7 (S,P)	Top of unconfined	Gamma scan (cesium-137, cobalt-60)	Iodine-129
299-W11-12 (P)	Top of unconfined		Strontium-90
299-W11-39	Top of unconfined	Gross alpha	Technetium-99
299-W11-40	Top of unconfined	Gross beta	Tritium
299-W11-41	Top of unconfined		
299-W11-42	Top of unconfined		

(a) All wells constructed to WAC 173-160-400 standards unless noted (P), pre-RCRA. All wells sampled quarterly unless noted (S), semiannually.
(b) Constituent list varies by well.
(c) Analyzed to support AEA monitoring.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act*.

Table B.38. Monitoring Wells and Constituents for Waste Management Area TX-TY (adapted from PNNL-12072-ICN-1)

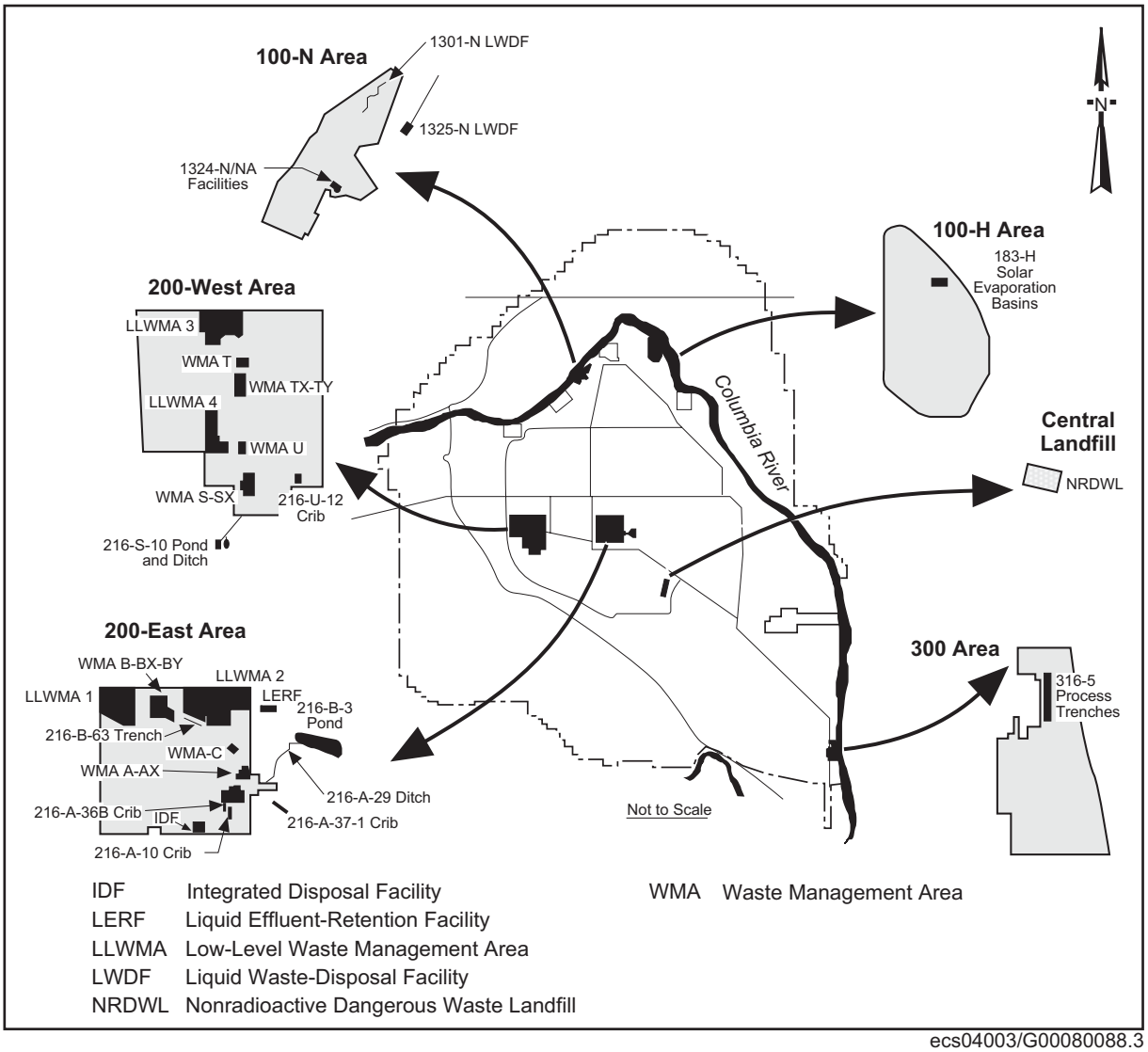
Well[a]	Hydrogeologic Unit Monitored	Contamination Indicator Parameters	
299-W10-17	Top of unconfined	pH (field)	Specific conductance (field)
299-W10-26	Top of unconfined		
299-W10-27	Top of unconfined	Site-Specific Parameters[b]	
299-W14-5 (P)	Top of unconfined	Alkalinity	ICP metals (filtered)
299-W14-6 (P)	Top of unconfined	Anions	Turbidity
299-W14-13	Top of unconfined		
299-W14-14	Top of unconfined	AEA Parameters[c]	
299-W14-15	Top of unconfined	Gamma scan (cesium-137, cobalt-60)	Iodine-129
299-W14-16	Top of unconfined		Strontium-90
299-W14-17	Top of unconfined	Gross alpha	Technetium-99
299-W14-18	Top of unconfined	Gross beta	Tritium
299-W14-19[d]	Top of unconfined		
299-W15-40	Top of unconfined		
299-W15-41	Top of unconfined		
299-W15-44[d]	Top of unconfined		
299-W15-763	Top of unconfined		
299-W15-765	Top of unconfined		

(a) All wells constructed to WAC 173-160-400 standards unless noted (P), pre-RCRA. All wells sampled quarterly, but not all constituents are sought quarterly.
(b) Constituent list varies by well.
(c) Analyzed to support AEA monitoring.
(d) New well added in fiscal year 2003.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.
RCRA = *Resource Conservation and Recovery Act*.

Table B.39. Monitoring Wells and Constituents for Waste Management Area U (adapted from PNNL-13612)

Well[a]	Contamination Indicator Parameters	
299-W18-30	pH (field)	Specific conductance (field)
299-W18-31		
299-W18-40	**Site-Specific Parameters**	
299-W19-12[b]	Alkalinity	ICP metals (filtered)
299-W19-41	Anions	Volatile organic compounds[c]
299-W19-42		
299-W19-44	**AEA Parameters[d]**	
299-W19-45	Gamma scan[c]	Technetium-99
	Gross alpha[c]	Tritium[c]
	Iodine-129[c]	

(a) All wells constructed to WAC-173-160-400 standards. All wells sampled quarterly. All wells completed at the top of the unconfined aquifer.
(b) Used for supplemental information; no statistical evaluations.
(c) Annually.
(d) Analyzed to support AEA monitoring.
Bold italic = Upgradient wells.
AEA = *Atomic Energy Act of 1954*.
ICP = Inductively coupled plasma emission spectroscopy.



ecs04003/G00080088.3

Figure B.1. Regulated Units on the Hanford Site Requiring Groundwater Monitoring. The 216-A-10, 216-A-36B, and 216-A-37-1 cribs are monitored as a single waste management unit, PUREX Cribs.

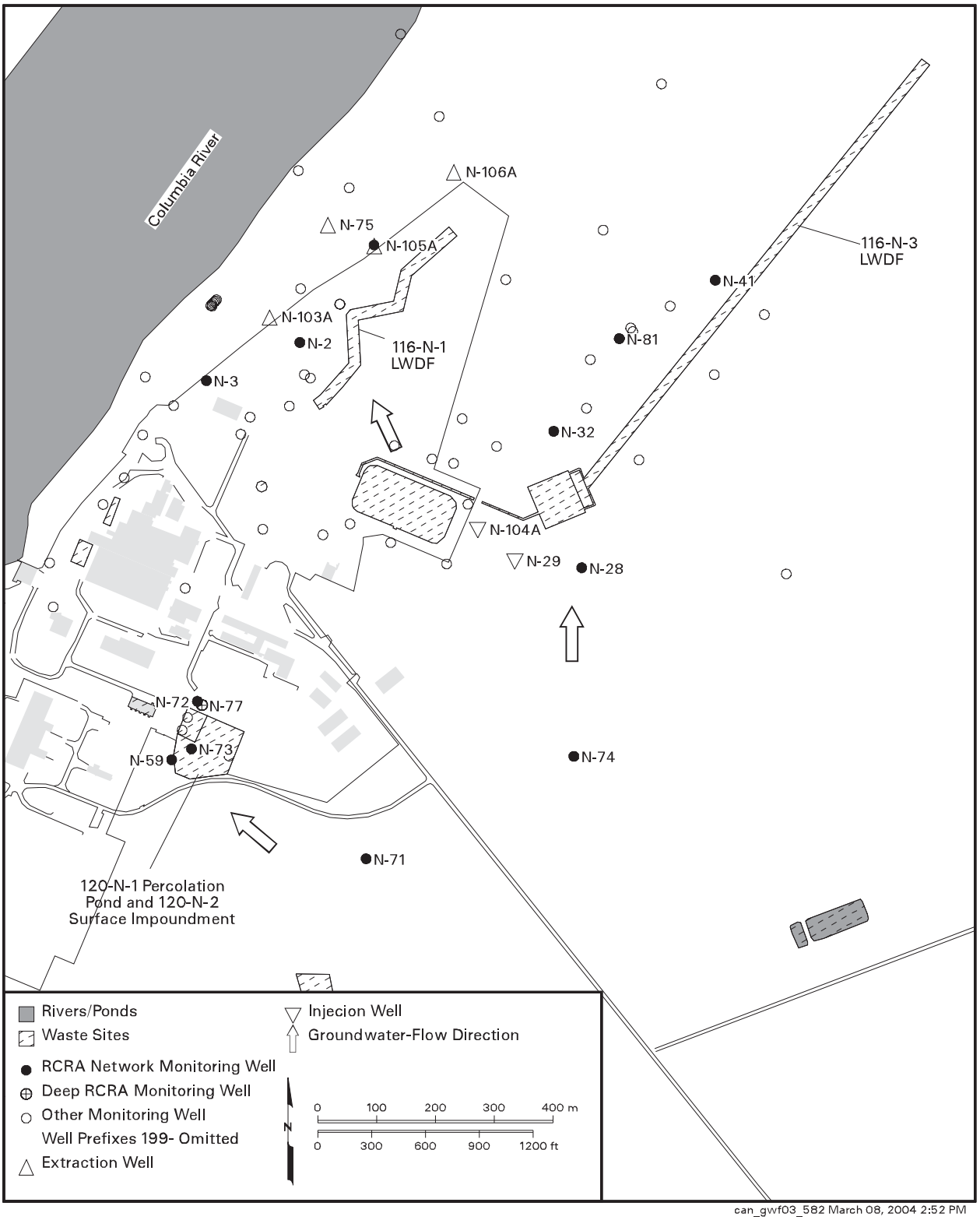


Figure B.2. Groundwater Monitoring Wells for the 100-N Area RCRA Sites

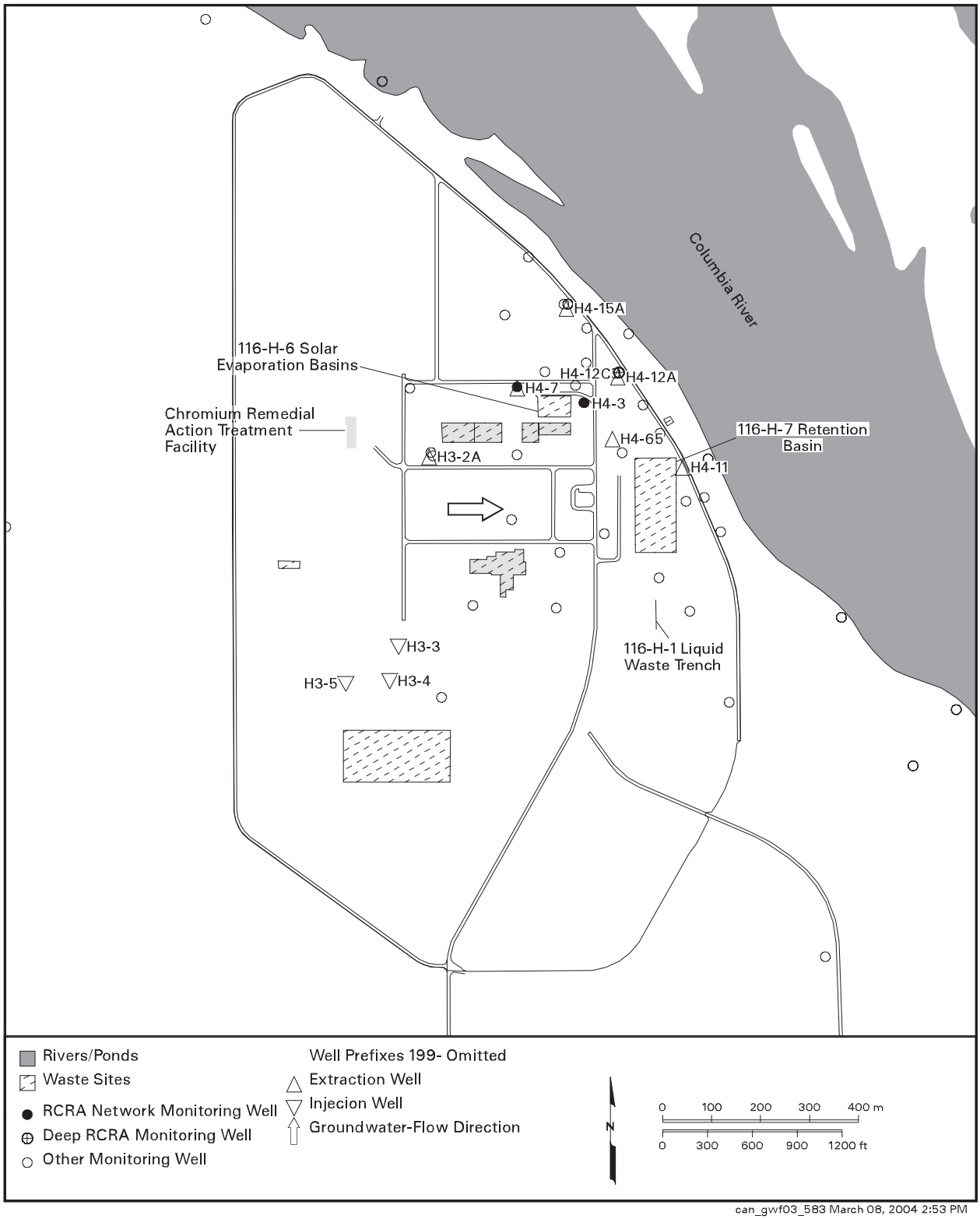


Figure B.3. Groundwater Monitoring Wells at the 116-H-6 (183-H) Evaporation Basins

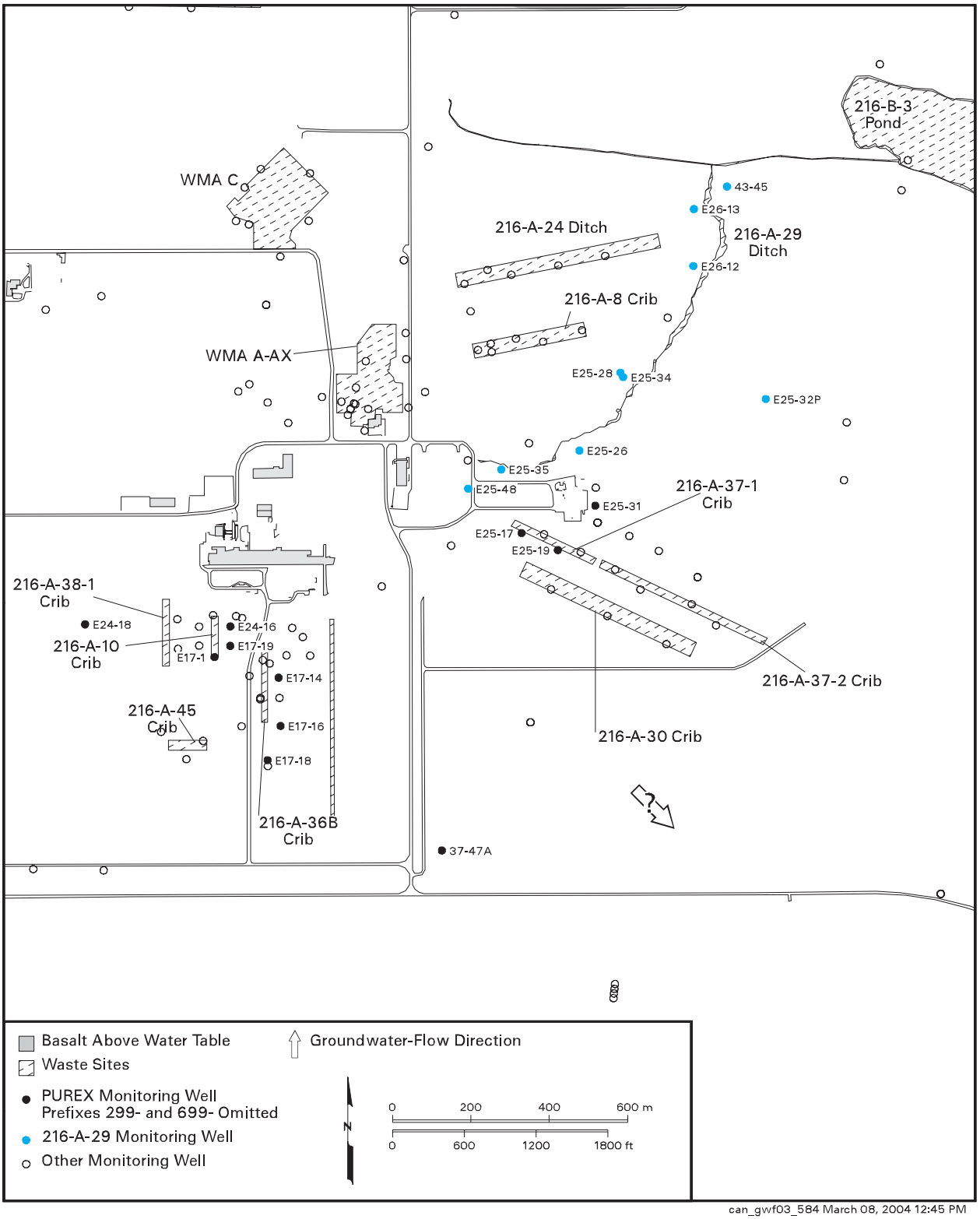


Figure B.4. Groundwater Monitoring Wells at the 216-A-29 Ditch and PUREX Cribs

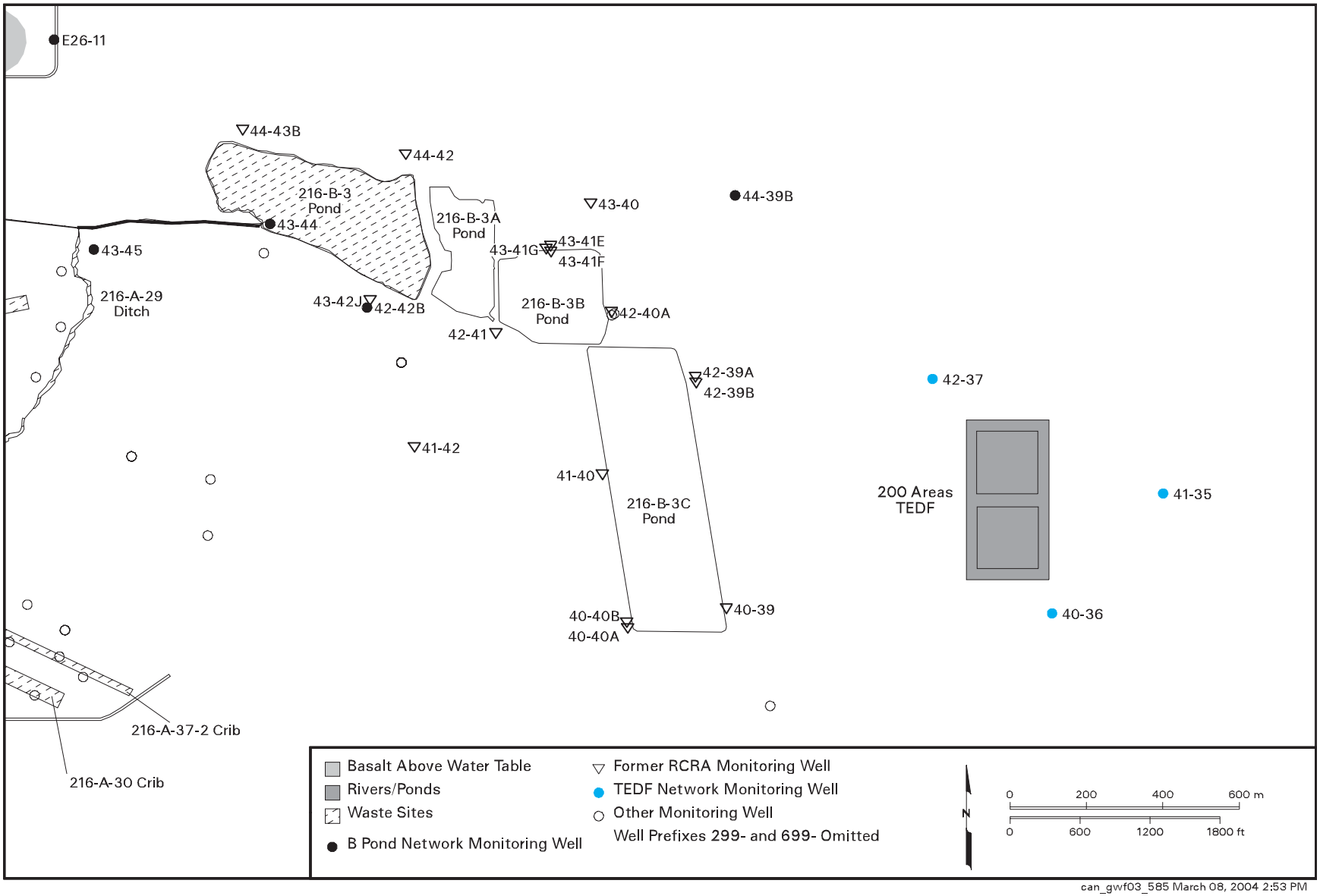


Figure B.5. Groundwater Monitoring Wells at the 216-B-3 Pond

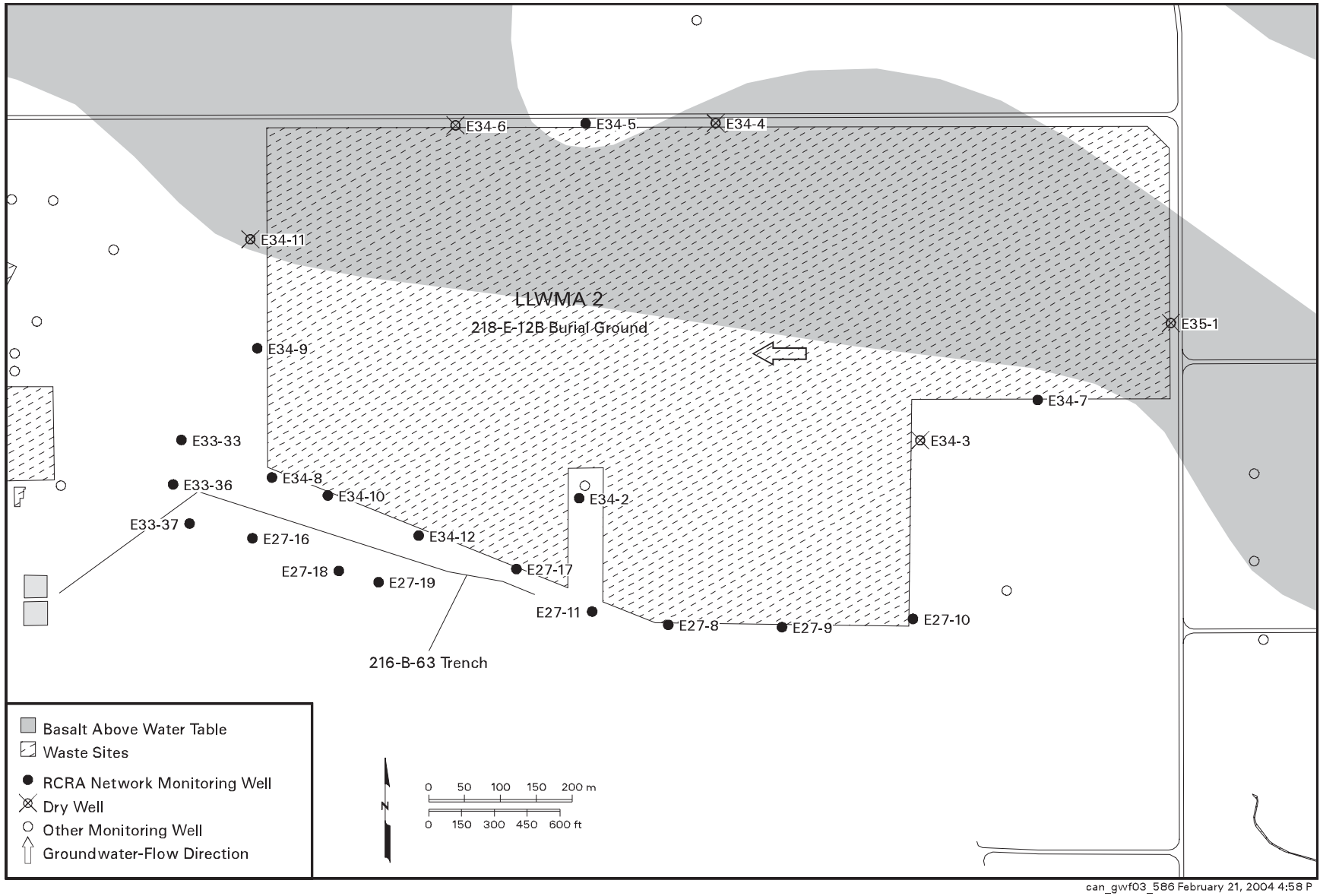


Figure B.6. Groundwater Monitoring Wells at the 216-B-63 Trench and Low-Level Waste Management Area 2

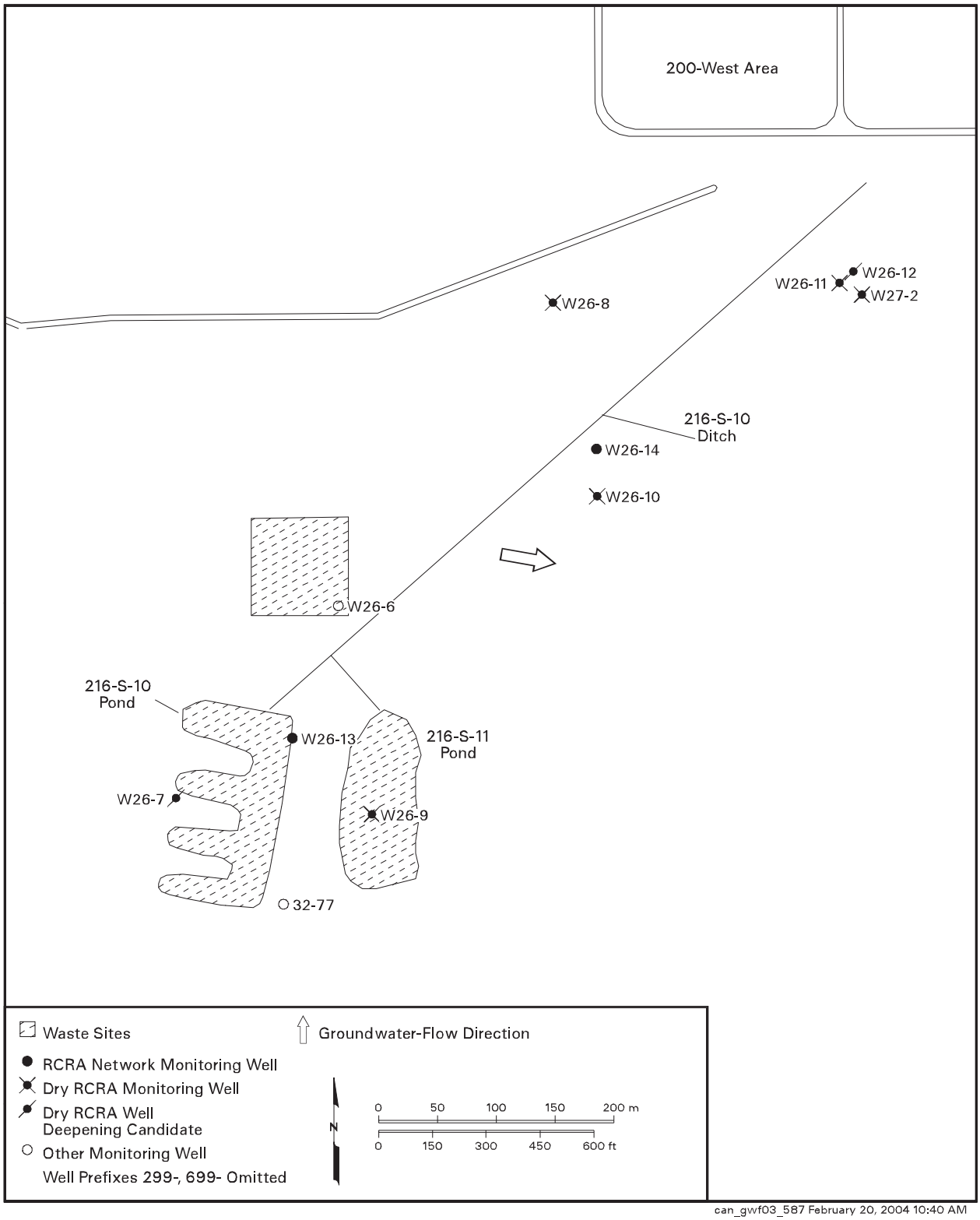


Figure B.7. Groundwater Monitoring Wells at the 216-S-10 Pond and Ditch

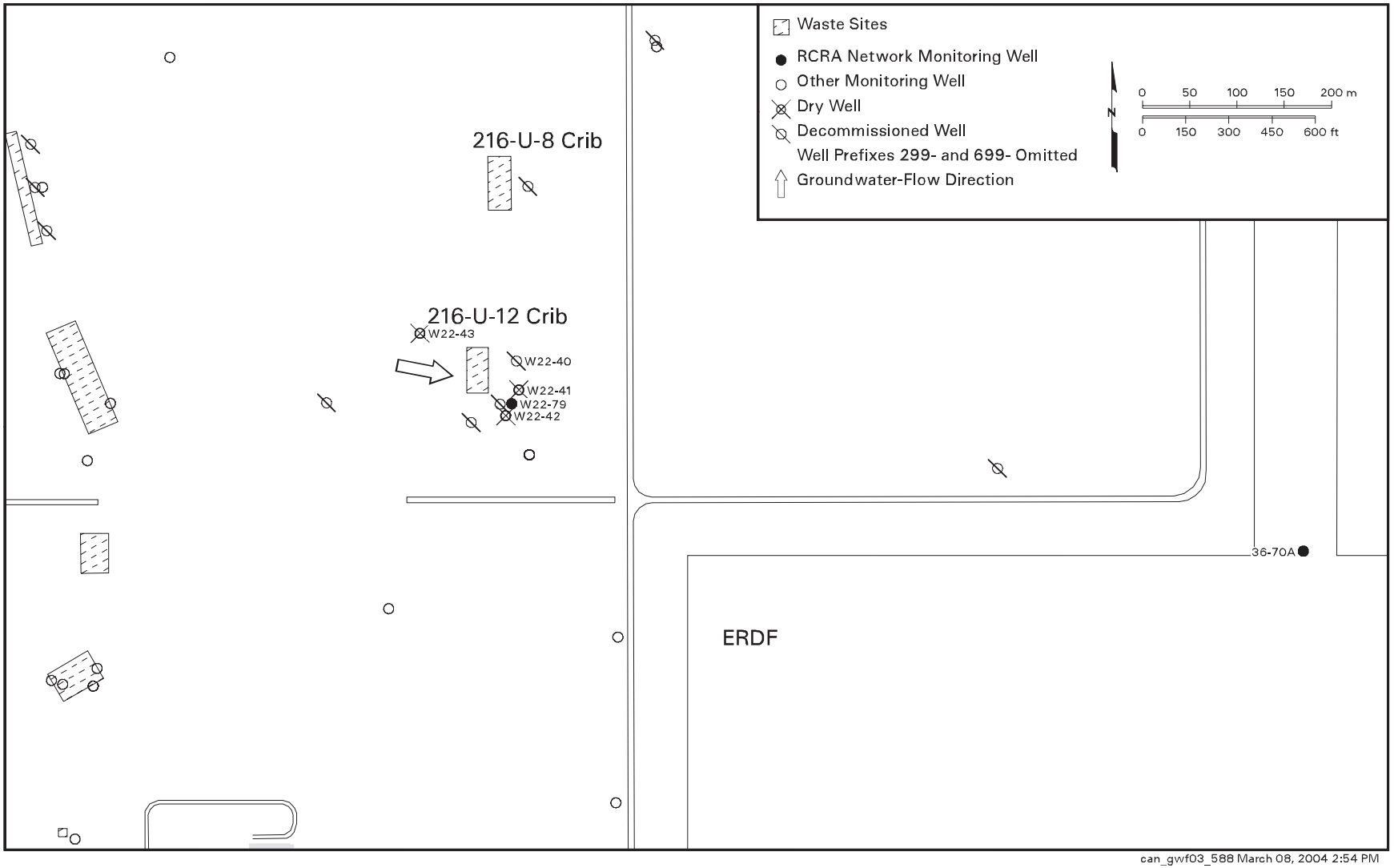


Figure B.8. Groundwater Monitoring Wells at the 216-U-12 Crib

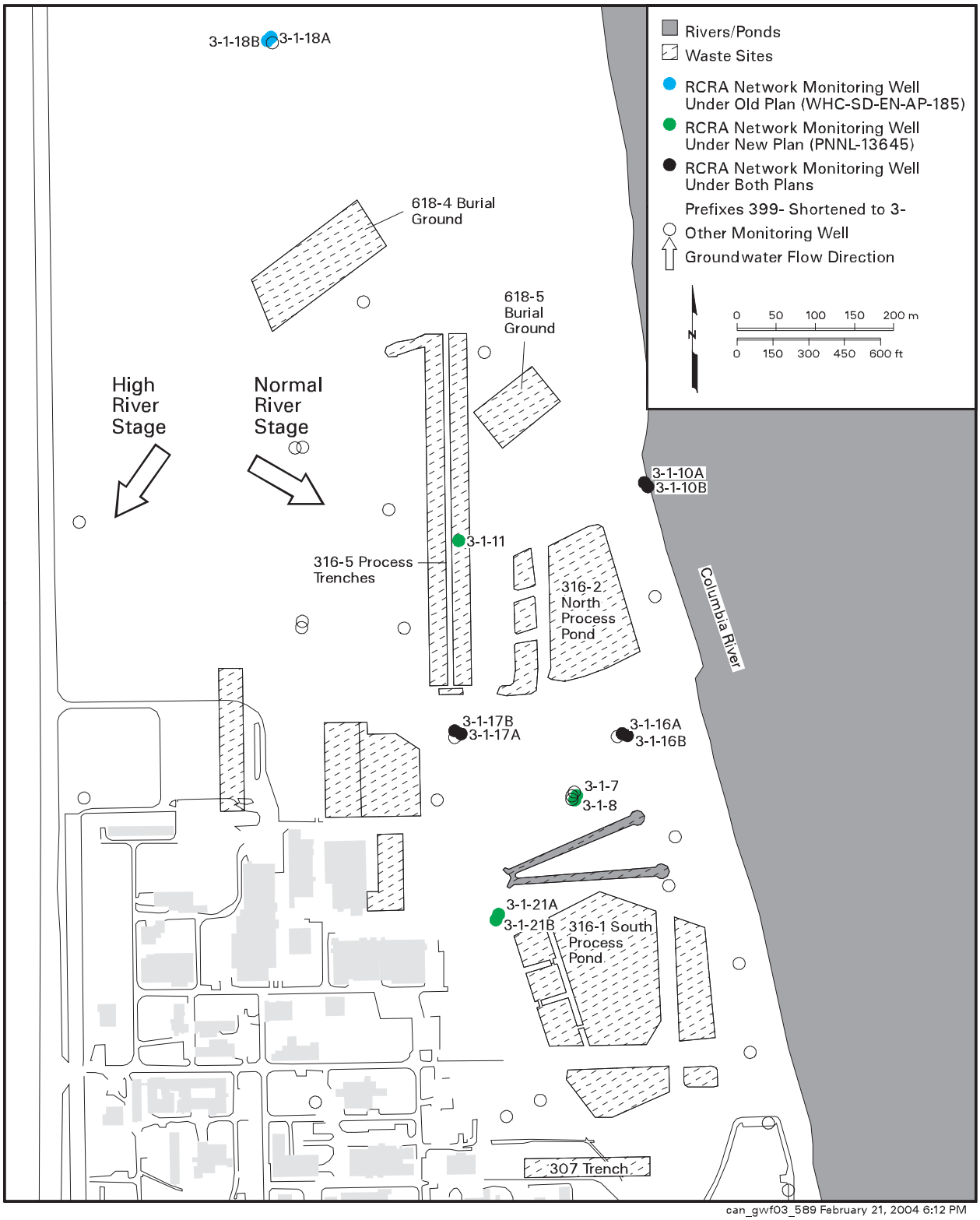


Figure B.9. Groundwater Monitoring Wells at the 316-5 Process Trenches

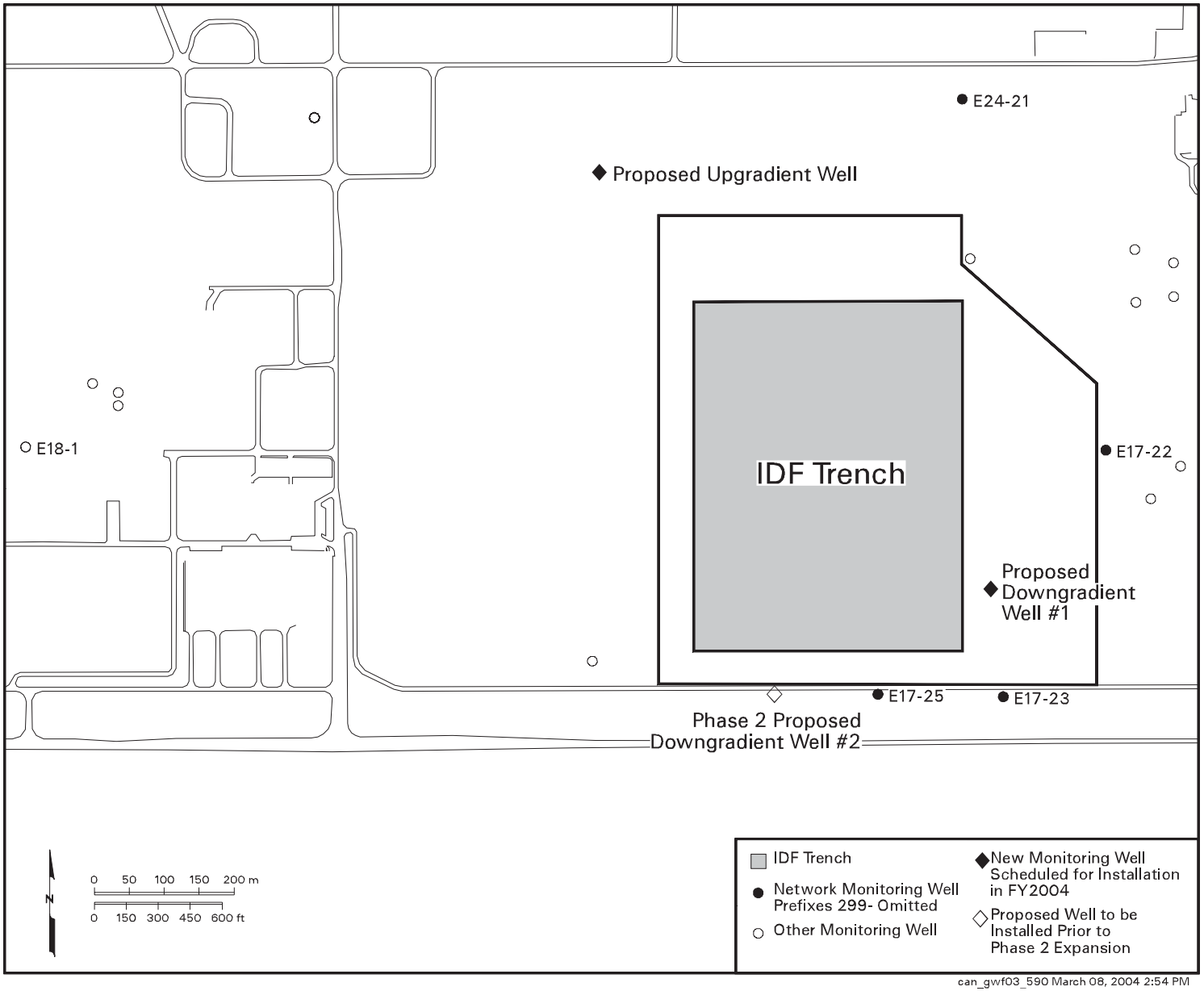


Figure B.10. Groundwater Monitoring Wells at the Integrated Disposal Facility

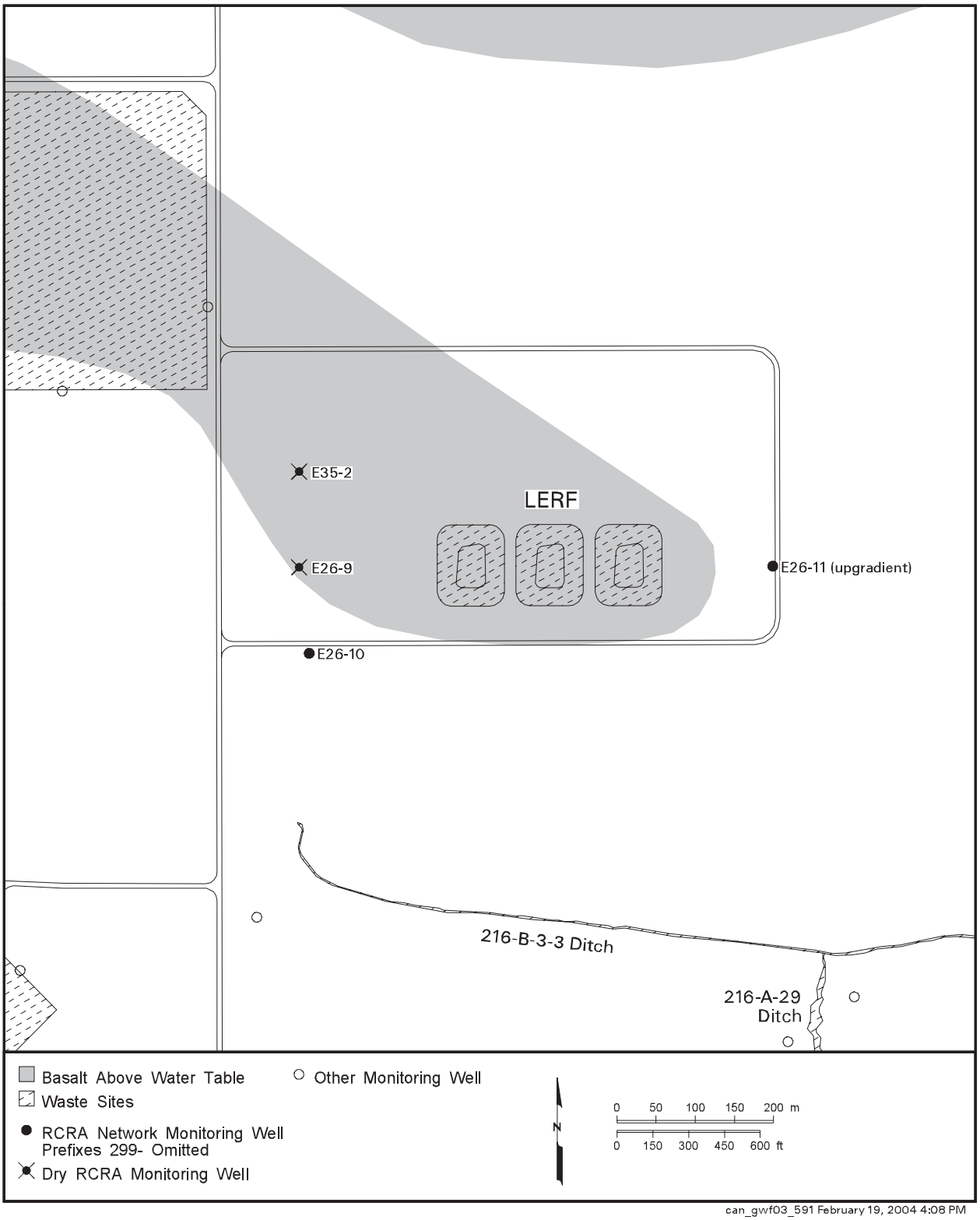


Figure B.11. Groundwater Monitoring Wells at the Liquid Effluent Retention Facility

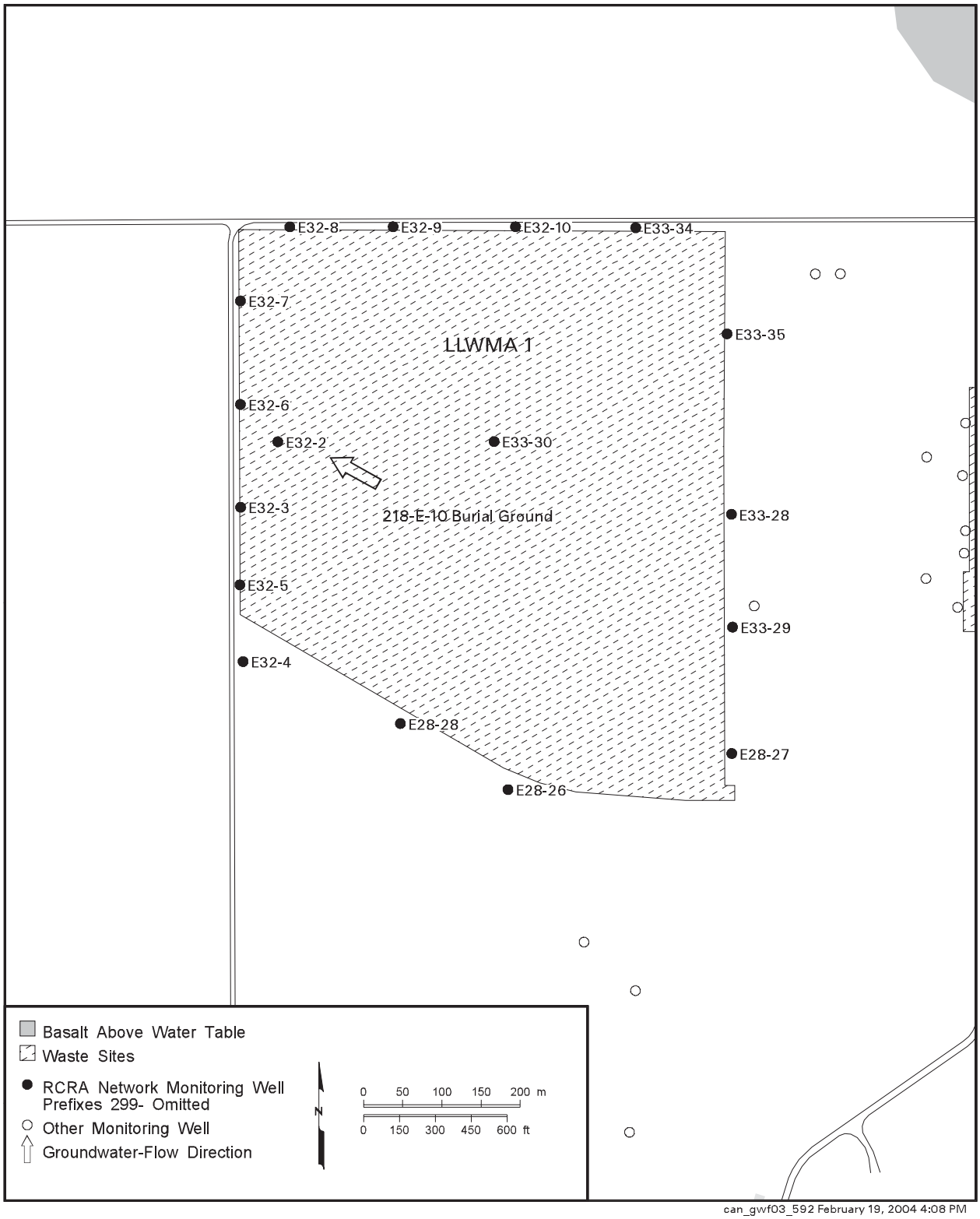


Figure B.12. Groundwater Monitoring Wells at Low-Level Waste Management Area 1

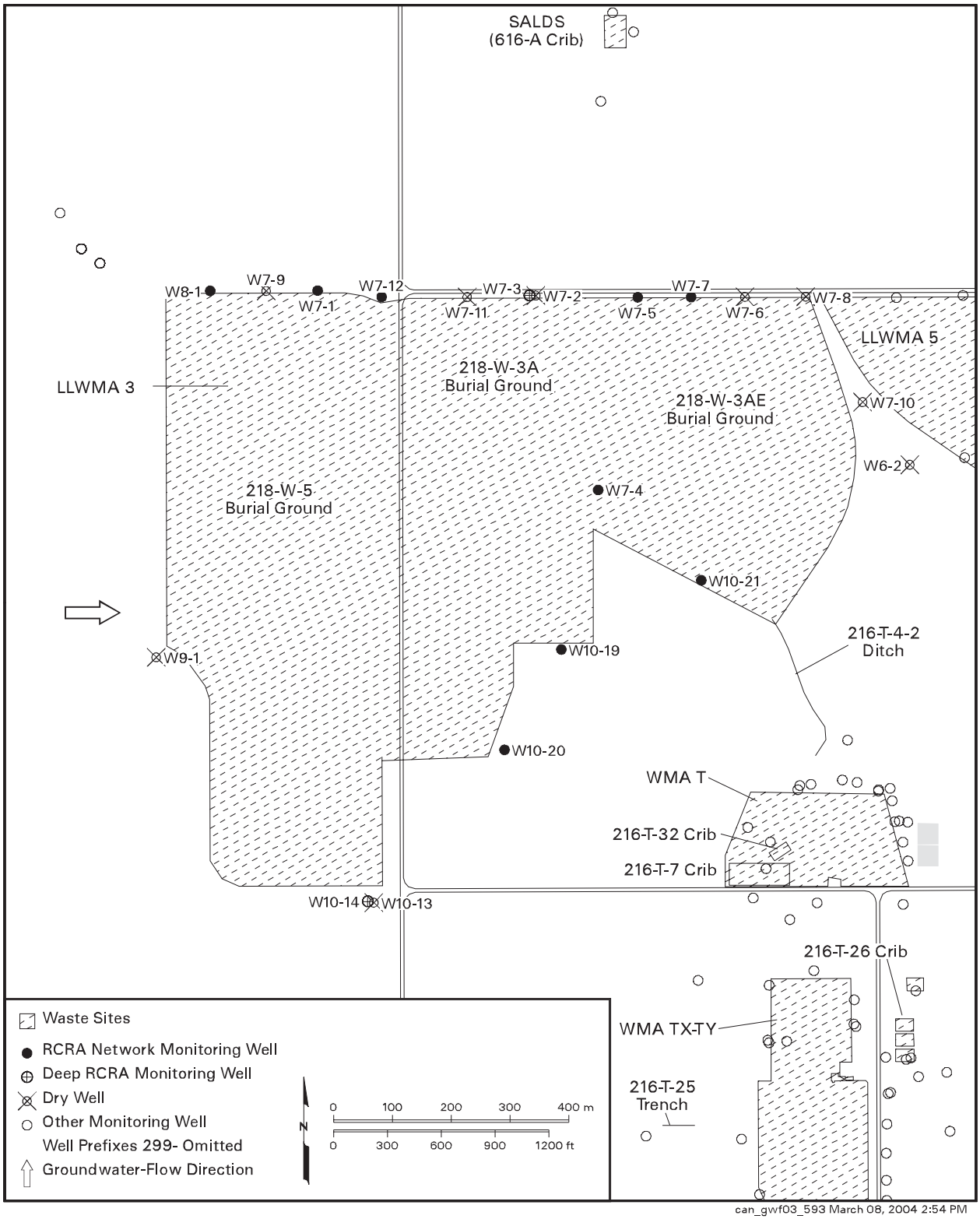


Figure B.13. Groundwater Monitoring Wells at Low-Level Waste Management Area 3

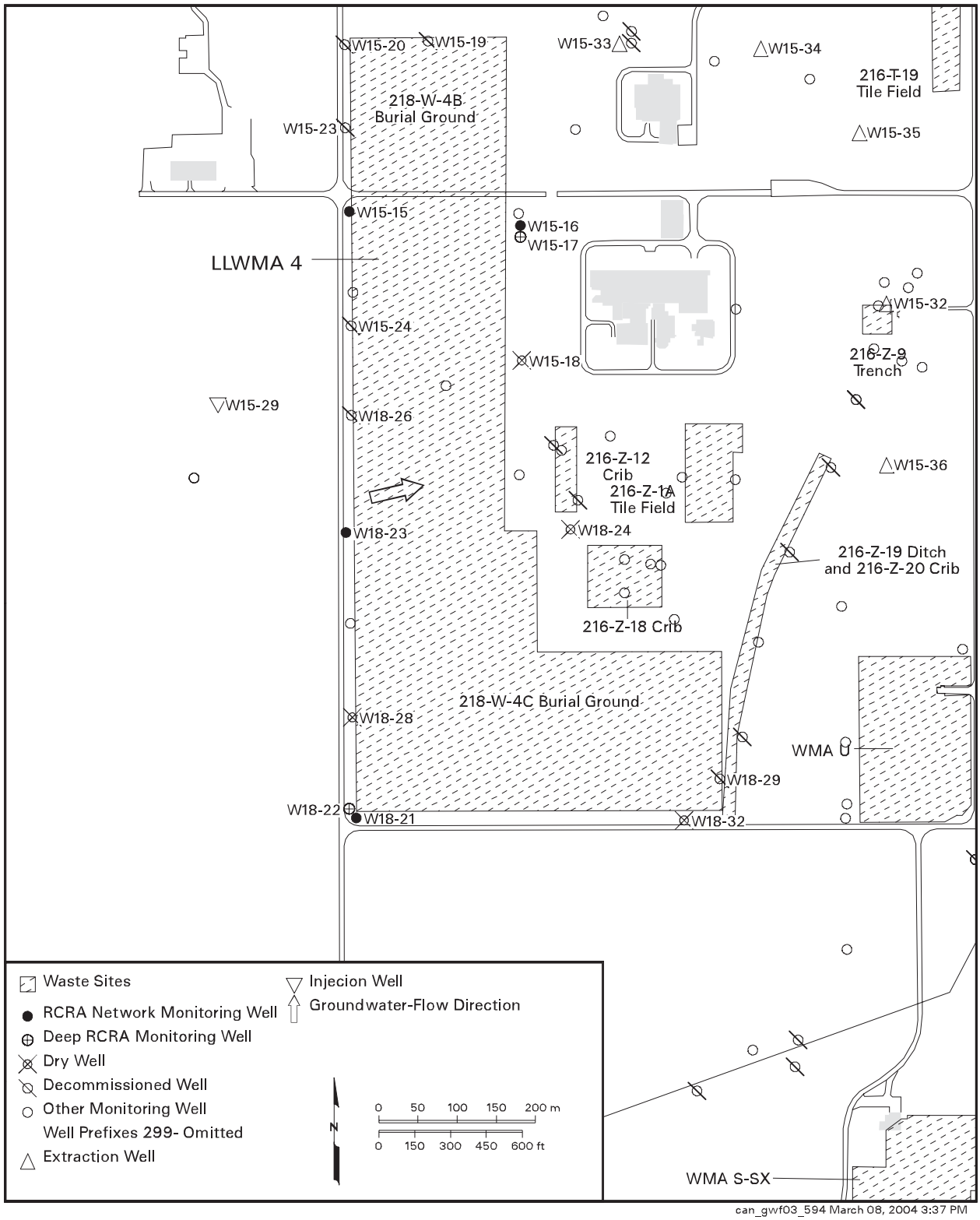


Figure B.14. Groundwater Monitoring Wells at Low-Level Waste Management Area 4

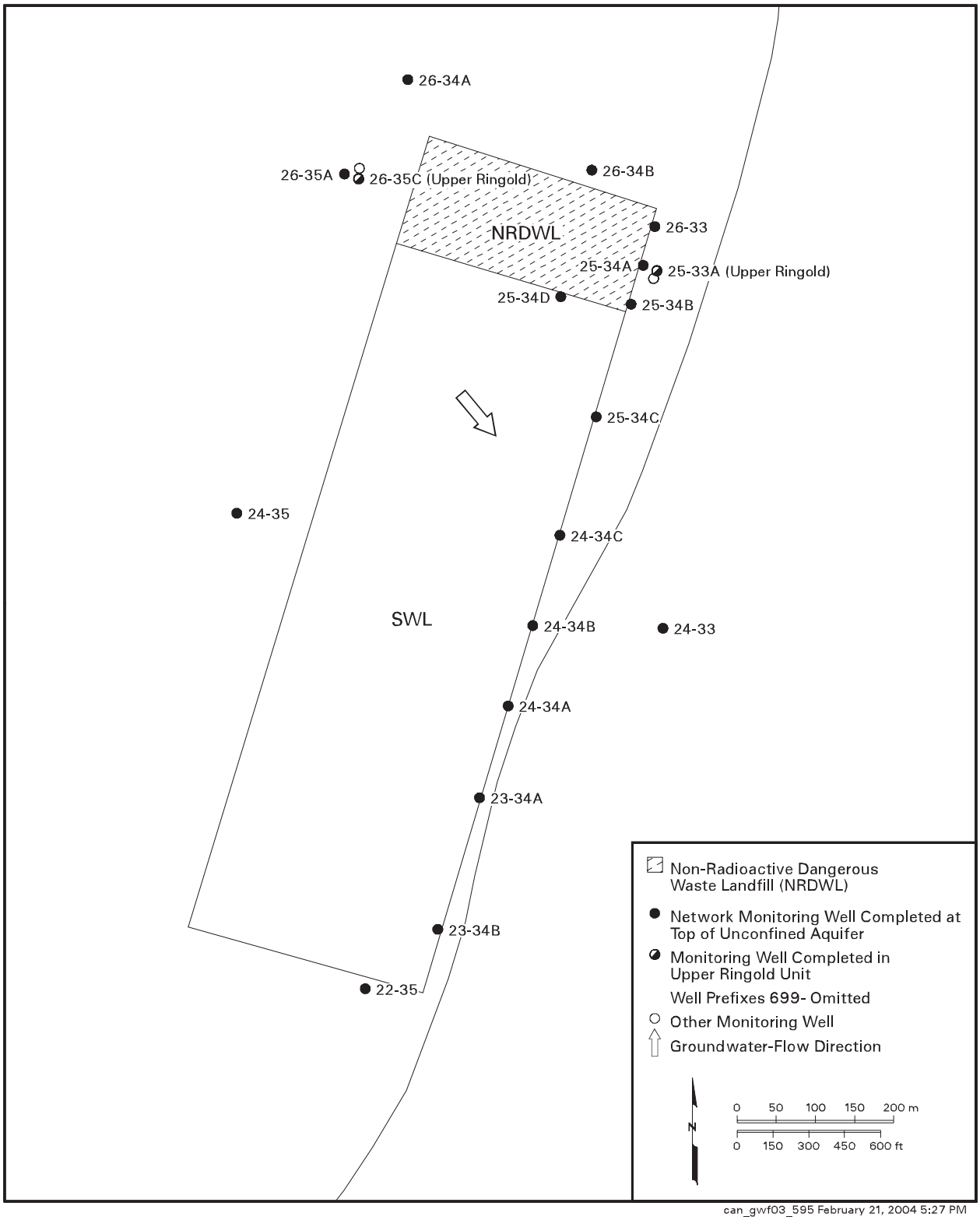


Figure B.15. Groundwater Monitoring Wells at the Nonradioactive Dangerous Waste Landfill

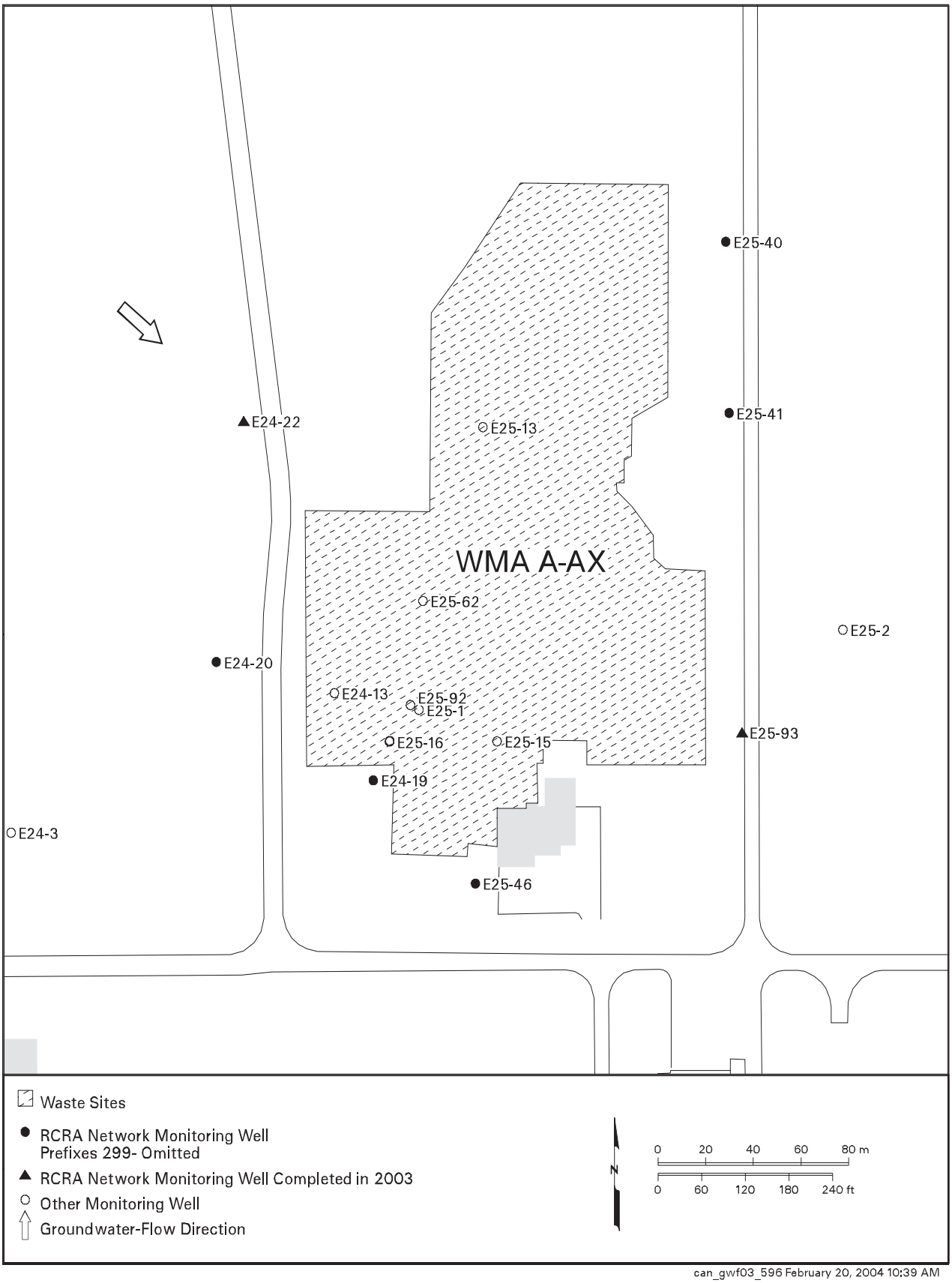


Figure B.16. Groundwater Monitoring Wells at Waste Management Area A-AX

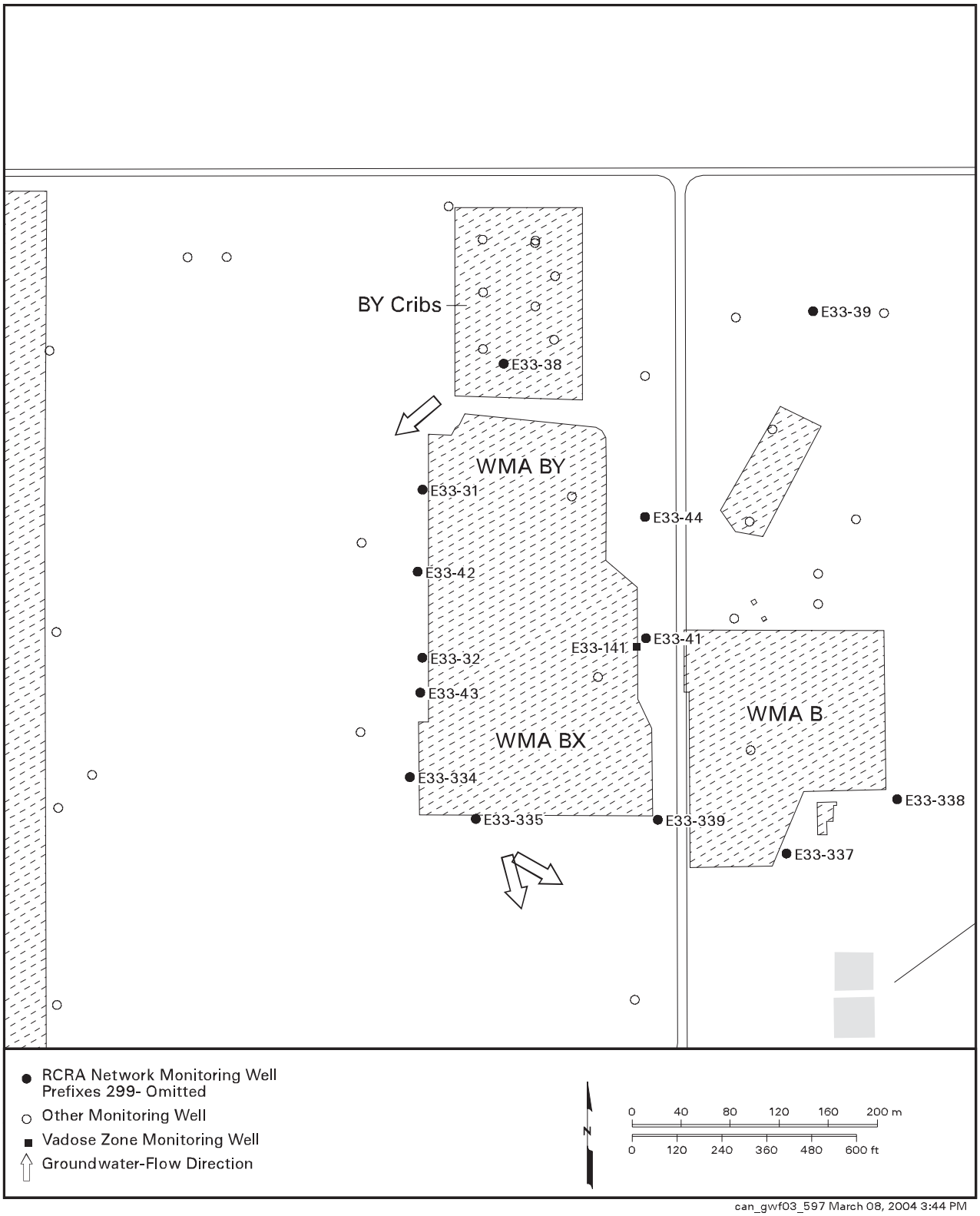


Figure B.17. Groundwater Monitoring Wells at Waste Management Area B-BX-BY

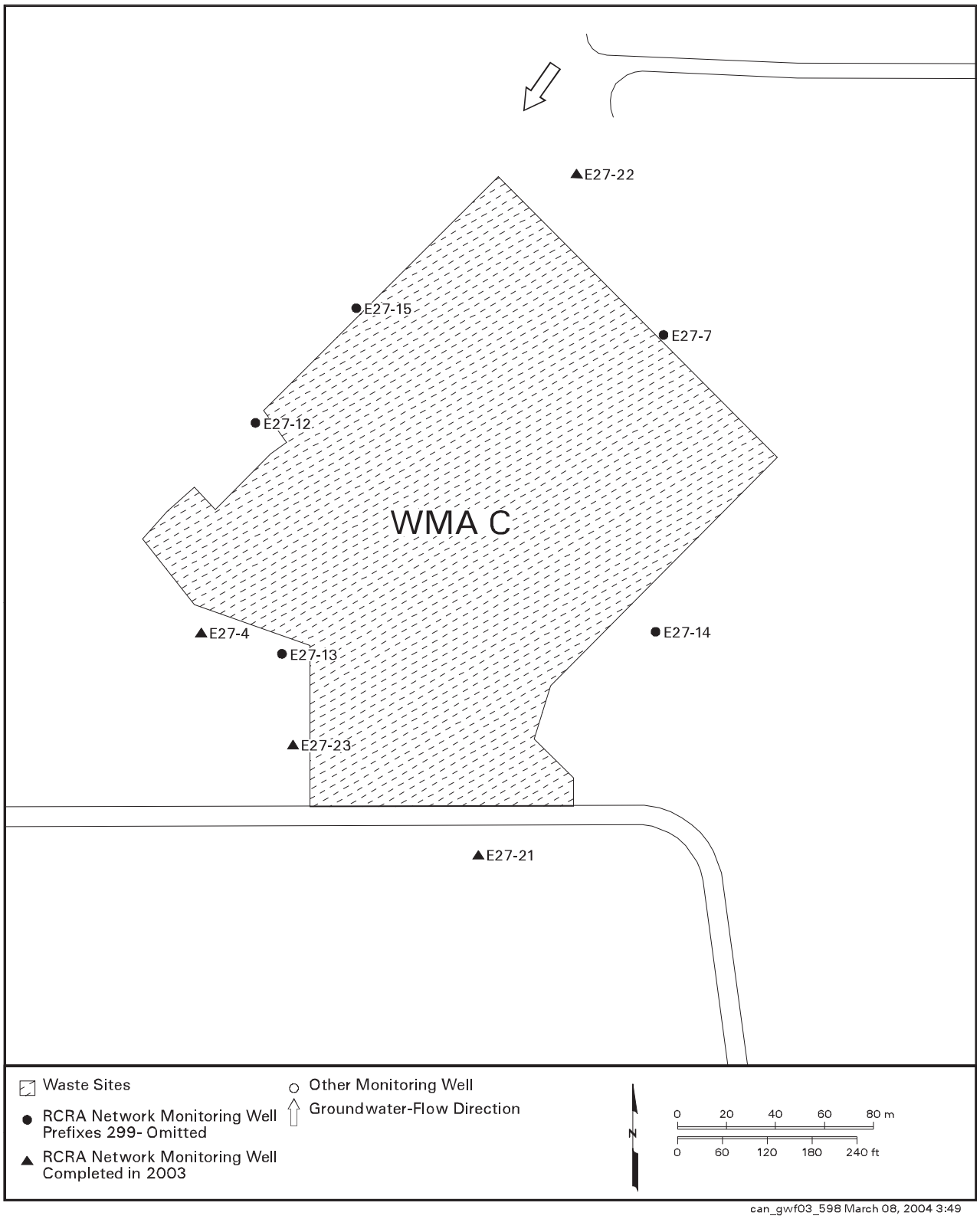


Figure B.18. Groundwater Monitoring Wells at Waste Management Area C

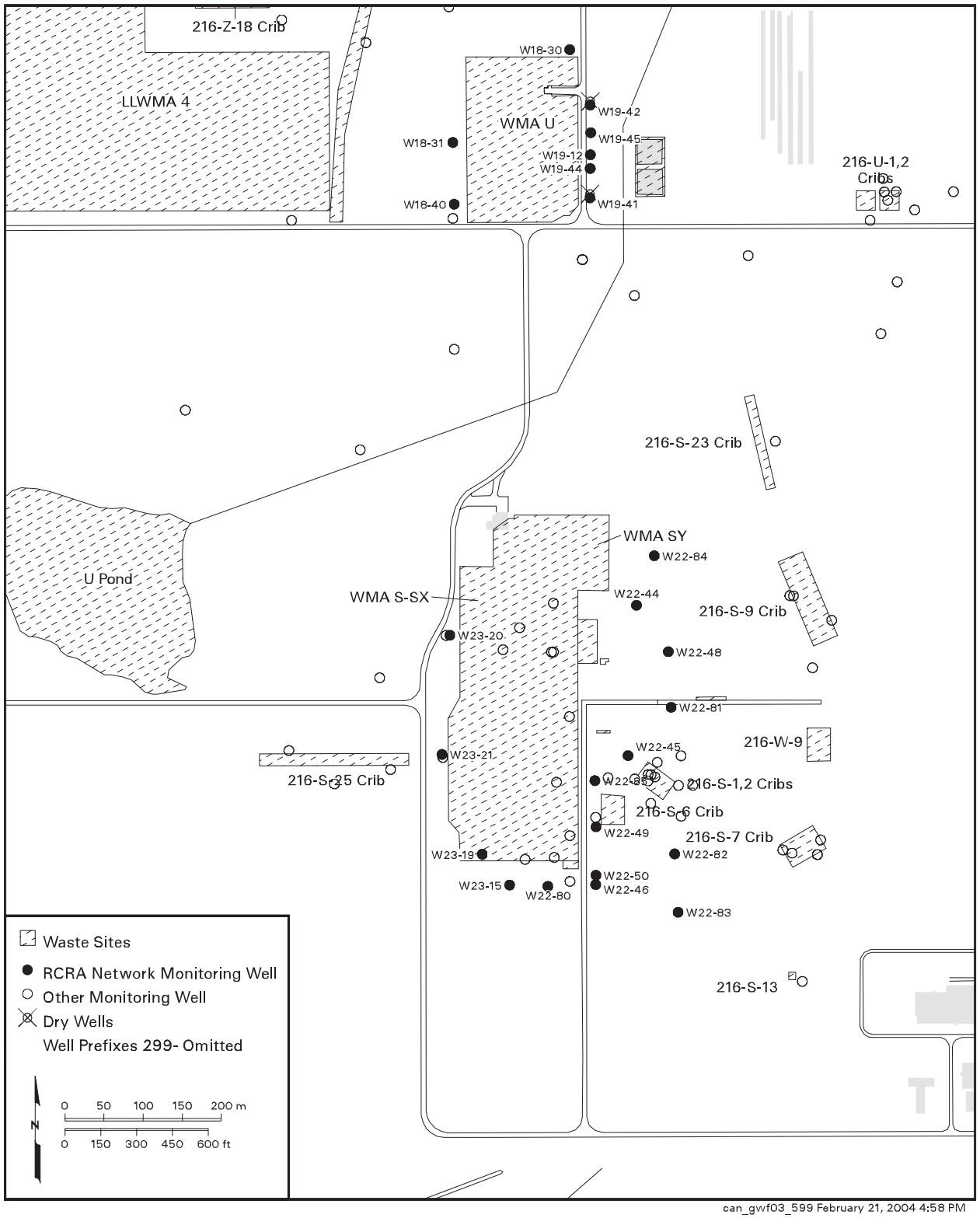


Figure B.19. Groundwater Monitoring Wells at Waste Management Areas S-SX and U

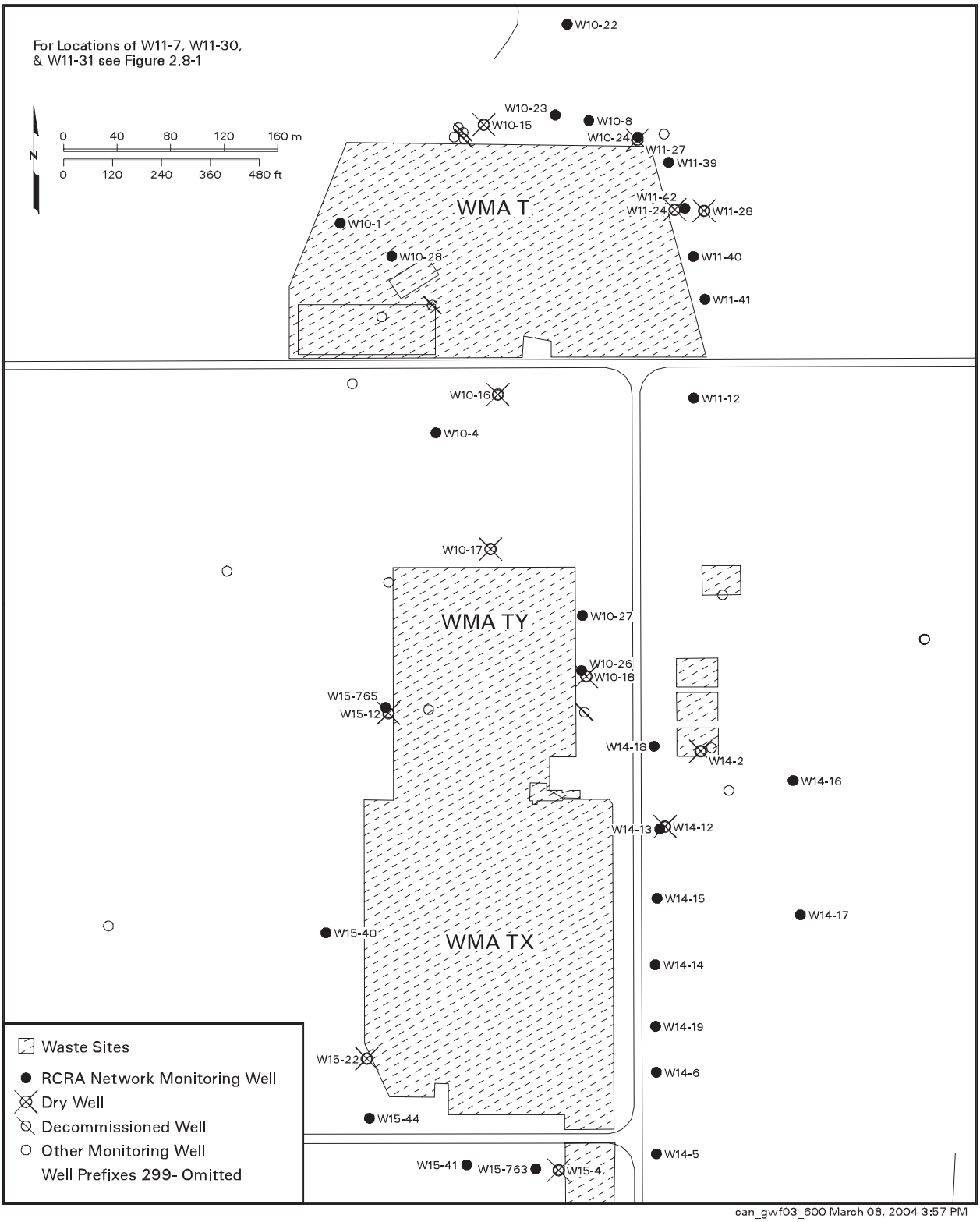


Figure B.20. Groundwater Monitoring Wells at Waste Management Areas T and TX-TY