2.0 Overview of Groundwater Flow

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This chapter provides a regional overview of groundwater flow beneath the Hanford Site. The uppermost aquifer beneath most of the site is unconfined and is composed of unconsolidated to semiconsolidated sediment of the Hanford formation and Ringold Formation, which was deposited on the basalt bedrock. In some areas, deeper portions of the aquifer are confined locally by layers of silt and clay. Deeper confined aquifers also occur within the underlying basalt and associated sedimentary interbeds (see Chapter 3.0). Wells in the 600 Area, which cover portions of the site other than the former operational areas, are shown in Figure 2-1. More detailed well location maps for specific areas are included in Chapters 4.0 through 8.0 of this volume, as well as in Chapters 13.0 through 19.0 in Volume 2 for the River Corridor.

During March 2009, a total of 829 water-level measurements were collected from wells monitoring the unconfined aquifer system and the underlying confined aquifers beneath the Hanford Site. The data were used for the following purposes:

- Prepare contour maps that indicate the general direction of groundwater movement within an aquifer
- Determine hydraulic gradients, which in conjunction with the hydraulic properties of the aquifer, are used to estimate groundwater flow velocities
- Interpret sampling results.

During March 2009, a total of 829 water-level measurements were collected across the Hanford Site. This information helps scientists understand the direction and rate of groundwater flow.

This chapter describes the results of a regional-scale analysis of these data for the unconfined aquifer, which is the aquifer most affected by Hanford Site operations. Local groundwater flow in each groundwater operable unit within the Central Plateau is described in Chapters 4.0 through 7.0 of this volume, as well as in Chapters 13.0 through 19.0 in Volume 2. The flow characteristics in the confined aquifer that are present in the lower Ringold Formation and in the upper basalt-confined aquifer system are discussed in Chapter 8.0. The collection and analysis of manual water-level measurements at the Hanford Site is described in *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project* (SGW-38815).

2.1 March 2009 Water Table Map

Figure 2-2 presents the Hanford Site water table map for March 2009. The water table mapping methodology is described in SGW-38815. In general, water-level measurements are displayed on a map using a geographic information system, and contours are hand-drawn by a hydrogeologist. Generation of the March 2009 map differed from the methodology described in SGW-38815 by using a software numerical-grid generation algorithm to guide the hand-generation of contours near the pump-and-treat systems. This resulted in a better representation of water table drawdown and buildup around extraction and injections wells, respectively. The software (KT3D_H2O) uses the statistical, kriging numerical-grid generation method and includes additional drift terms in the kriging equation to represent extraction and injection wells ("Kriging Water Levels with a Regional-Linear and Point-Logarithmic Drift" [Tonkin and Larson 2002]; "KT3D_H2O: A Program for Kriging Water Level Data Using Hydrologic Drift Terms" [Karanovic et al. 2009]; SGW-42305, *Collection and Mapping of Water Levels to Assist in the Evaluation of Groundwater Pump-and-Treat Remedy Performance*). Details of the water table configuration near the pump-and-treat systems are not evident in Figure 2-2 because of the small scale of the map but are evident on the larger scale water table maps presented in this report.

Groundwater in the unconfined aquifer generally flows west to east beneath the Hanford Site and discharges to the Columbia River.

Groundwater in the unconfined aquifer generally flows from upland areas in the west toward the regional discharge area north and east along the Columbia River. Steep hydraulic gradients occur in the west, east, and north regions of the Hanford Site. Shallow gradients occur southeast of the 100-F Area and in a broad arc extending from west of the 100-B/C Area, toward the southeast between Gable Butte and Gable Mountain (Gable Gap) and the 200 East Area into the central portion of the site. The steep gradients in the west and east are associated with low-permeability sediment of the Ringold Formation at the water table, while the low gradients are associated with highly permeable sand and gravel of the Hanford formation at the water table.

North of Gable Butte and Gable Mountain, groundwater flow directions vary from northwest to east depending on the location. Groundwater enters this region through the gaps between Gable Mountain, Gable Butte, and Umtanum Ridge (Figure 2-2), as well as from natural recharge. The Columbia River also recharges the unconfined aquifer west of the 100-B/C Area. Water flowing north through Gable Gap fans out and flows north-northwest toward the Columbia River, as well as toward the northeast and east along the north side of Gable Mountain. Recharge water from the Columbia River and the gap between Umtanum Ridge and Gable Butte is thought to flow east toward the 100-B/C Area and discharge to the river near that area. In the 100 Areas, the local groundwater flow is generally toward the Columbia River, although this pattern is altered by pump-and-treat remediation systems in the 100-K, 100-D, and 100-H Areas. During periods of high river stage, the Columbia River temporarily recharges the adjacent aquifer all along the river (bank storage effects).

An apparent groundwater mound exists ~2 kilometers north of Gable Mountain and is associated with low-conductivity Ringold Formation mud at the water table. This mound is contoured as if it were part of the unconfined aquifer (Figure 2-2), but it could represent a perched water table above the regional water table. Additional data are needed to distinguish between these alternatives. Water-level elevations indicate that groundwater moving east along the north side of Gable Mountain flows around this apparent mound.

South of Gable Butte and Gable Mountain, natural recharge to the aquifer comes from the Cold Creek Valley, Dry Creek Valley, Rattlesnake Hills, Yakima River, and infiltrating precipitation. Groundwater generally flows from west to east, although some of the flow from the 200 West Area or north of the 200 West Area turns north and flows through Gable Gap. Previous effluent discharges at U Pond and other facilities caused a groundwater mound to form beneath the 200 West Area that significantly affected regional flow patterns in the past. These discharges largely ceased by the mid-1990s, but a remnant mound remains, which is apparent from the shape of the water table contours passing through the 200 West Area. Currently, the water table elevation is ~11 meters above the estimated water table elevation prior to the start of Hanford Site operations.[1] Equilibrium conditions will be re-established in the aquifer after dissipation of the mound caused by artificial recharge. When this occurs, the water table may still be ~5 to 7 meters higher than before Hanford Site operations began because of increased irrigation activities west of the site. The water

1 Based on the March 2009 water-level elevation in well 299-W18-15 (135.8 meters NAVD88) and the pre-Hanford water table elevation at the location of this well estimated from Selected Water Table Contour Maps and Well Hydrographs for the Hanford Reservation (BNWL-B-360) (~125.1 meters NAVD88). The peak historical water-level elevation within the 200 West Area occurred at well 299-W18-15 in 1984 (149.1 meters NAVD88).

table beneath the 200 West Area is perturbed locally by current discharges from the State-Approved Land Disposal Site, as well as by operation of a groundwater pump-and-treat remediation system at the 200-ZP-1 Operable Unit.

Groundwater flow in the central portion of the Hanford Site (encompassing the 200 East Area) is substantially affected by the presence of a buried flood channel, which lies in a northwest to southeast orientation (PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*). The water table in this area is very flat (i.e., the magnitude of the hydraulic gradient is estimated to be ~10^{-5} m/m or less) because of the high permeability of the Hanford formation sediments. Groundwater flow in this region is affected by the presence of low-permeability sediment (i.e., muds) of the Ringold Formation at the water table east and northeast of the 200 East Area, as well as basalt above the water table. These features generally constitute barriers to groundwater flow, although the unconfined aquifer can occur in the basalt flow top where it has not been removed by erosion. The extent of the basalt units above the water table continues to increase slowly because of the declining water table, resulting in an even greater effect on groundwater flow in this area. The water table beneath the 200 East Area is ~1.9 meters higher than estimated pre-Hanford conditions.[2] When equilibrium conditions are re-established, the water table in the 200 East Area is expected to return to very near the pre-Hanford elevation.

The water table in the 200 East Area is very flat, which makes flow direction determinations difficult.

Water enters the 200 East Area and vicinity from the west and southwest, as well as from beneath the mud units to the east and from the underlying aquifers where the confining units have been removed or thinned by erosion. The flow of water divides beneath the 200 East Area, with some water flowing to the north through Gable Gap and some flowing southeast toward the central portion of the site. The specific location of the groundwater flow divide is not certain because the flat nature of the water table in the 200 East Area makes determining flow directions difficult (see Section 2.3). It is known that groundwater flows north through Gable Gap because the hydraulic gradient within the gap area is large enough to be determined using water-level data. During fiscal year (FY) 2009, the gradient magnitude in Gable Gap averaged 8.4 x 10^{-5} m/m along a north flow direction, but flow conditions vary during the year because of changes in Columbia River stage (DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*). Groundwater is inferred to flow southeast within the region between the 200 East Area and the Hanford Central Landfill because the average water-level elevation at the landfill (121.80 meters North American Vertical Datum of 1988 [NAVD88] for March 2009) is 0.12 meters lower than the average elevation in the 200 East Area (121.92 meters NAVD88 for March 2009). This yields a regional hydraulic gradient magnitude of ~1.5 x 10^{-5} m/m.

Between the area southeast of the Central Landfill to the 300 Area, the highly permeable sediments of the Hanford formation occur above the water table. These sediments intercept the water table again at the 300 Area. For this reason, the hydraulic gradient magnitude in the 300 Area is also very low. Groundwater flow converges on the 300 Area from the northwest, west, and southwest, then generally moves along a southeast flow path and discharges to the Columbia River (PNNL-15127, *Contaminants of Potential Concern in the 300-FF-5 Operable Unit: Expanded Annual Groundwater Report for Fiscal Year 2004*).

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2 Based on the average water-level elevation measured in 31 wells within the 200 East Area during March 2009, all of which have been corrected for deviations of the boreholes from true vertical (121.92 meters NAVD88), and the pre-Hanford water table elevation for the 200 East Area estimated from BNWL-B-360 (~120 meters NAVD88).

2.2 Water Table Change from March 2008

The water table continued to decline over much of the Hanford Site. The decline is due to the reduction of effluent discharges to the ground during the 1980s and 1990s.

The water table elevation continued to decline over much of the Hanford Site from March 2008 to March 2009. The decline is a result of the reduction of effluent discharges to the ground during the 1980s and 1990s. The largest widespread declines occurred within the 200 West Area, where the water table elevation decreased by an average of 0.35 meters. The water table elevation increased in the Richland area between the Yakima and Columbia Rivers, in a few wells along the Rattlesnake Hills, in one well within the Dry Creek Valley, and in a few wells along the Columbia River. When considering only those wells not associated with pump-and-treat systems, the largest increase was 2.24 meters in well 1199-39-16A at the City of Richland North Well Field, and the largest decrease was 0.69 meters in well 699-48-77A at the State-Approved Land Disposal Site (north of the 200 West Area). These changes are attributed to operation of the associated facilities.

In the 200 East Area, the elevation of the water table declined by an average of 0.09 meters between March 2008 and March 2009, which was larger than the previous one-year decline of 0.01 meters (DOE/RL-2008-66). The smaller decline the previous year was attributed to increased effluent discharges at the Treated Effluent Disposal Facility (TEDF), which is located east of the 200 East Area. The discharge volume was again elevated between March and June 2009, which caused a fluctuation in the 200 East Area water table elevation during the summer of 2009 (Figure 2-3).

2.3 200 East Area Hydraulic Gradient Evaluation

As described in Section 2.1, the water table in the 200 East Area is very flat, due primarily to the high permeability of the Hanford formation and the presence of a groundwater flow divide in this area. The estimated regional hydraulic gradient magnitude of ~1.5×10^{-5} m/m (Section 2.1) equates to a change of 1.5 centimeters in water table elevation per kilometer. The distance from the northwest to the southeast corners of the 200 East Area is ~4 kilometers, so the water table elevation is expected to change no more than ~6 centimeters within the 200 East Area. However, because a flow divide is interpreted to exist within this area, the actual water table elevation change is expected to be less. Water-level data collected from the 200 East Area prior to this study exhibited a range of ~10 centimeters. Thus, existing water-level data have not been accurate enough to determine hydraulic gradients within the 200 East Area.

A study is being conducted to determine groundwater flow directions in the 200 East Area to support groundwater monitoring at RCRA waste sites.

Several *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and disposal (TSD) units are located within the 200 East Area. Groundwater monitoring under RCRA regulations requires that the groundwater flow direction be determined beneath each RCRA TSD unit to distinguish between upgradient and downgradient monitoring wells (e.g., 40 *Code of Federal Regulations* [CFR] 265.91[a], "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities; Ground-Water Monitoring System," as referenced by *Washington Administrative Code* [WAC] 173-303-400, "Dangerous Waste Regulations; Interim Status Facility Standards," for sites monitored under interim status regulations). Therefore, a study has been ongoing since September 2005 to improve the accuracy of water-level measurements in the 200 East Area so groundwater flow directions beneath the RCRA TSD units can be determined.

This study has been performed at two locations: Low-Level Waste Management Area 1 (LLWMA-1) in the northwestern portion of the 200 East Area, and the Integrated Disposal Facility (IDF)/Plutonium Uranium Extraction (PUREX) Cribs in the southeast. A network of wells was established at each site, with the wells chosen so long screen intervals were avoided where possible. The well networks for each site are shown in Figure 2-4 for LLWMA-1 and Figure 2-5 for the IDF/PUREX Cribs. The network for LLWMA-1 initially consisted of ten wells, but four additional wells (299-E18-1, 299-E28-17, 699-49-55A, and 699-50-56) were added in early 2008, forming a network of fourteen wells.

Gyroscope and elevation surveys were performed for each well to improve the accuracy of the water-level measurements. The gyroscope surveys were performed to correct for deviations of the wellbores from vertical. Such deviations result in a measured depth to water that is larger than the true vertical depth to water and, therefore, a calculated water-level elevation that is lower than the true elevation. A gyroscope survey maps the position of the wellbore in three-dimensional space that allows for the difference between the measured and true vertical depths to water to be determined. The largest correction value during this study was 0.47 meters (47 centimeters), and the average correction value was 0.06 meters (6 centimeters).

Casing elevation surveys were performed to a higher degree of accuracy than is normally performed for monitoring wells at the Hanford Site. Leveling surveys were performed for each well network using an infrared sighting device (a one-piece invar rod) and double runs between wells. Each network was referenced to a single benchmark. All surveys were performed in loops that closed on the starting point, allowing for misclosure values[3] to be determined. The largest misclosure value was 0.003 meters (0.3 centimeters) and the average misclosure was 0.0011 meters (0.11 centimeters), indicating that high accuracy was achieved.

The accuracy of water-level measurements in the 200 East Area was improved by conducting wellbore deviation surveys and highly accurate casing elevation surveys.

Water-level measurements were collected using measuring tapes dedicated to this study. The initial measuring tape used was calibrated by a standards laboratory and found to be accurate to within 0.001 meter (1 millimeter) throughout its length. The water-level measurements were analyzed by trend-surface analysis, in which a plane is fitted to a set of water-level measurements by least-squares regression. The hydraulic gradient direction corresponds to the dip direction of the fitted plane, and the amount of dip represents the hydraulic gradient magnitude. The degree to which the plane represented the data (i.e., the goodness of fit) was assessed by an analysis of variance statistical test. This test identifies whether the data exhibit a true spatially dependent trend to an acceptable probability of error (i.e., the level of significance), which was chosen to be 0.05 for this study (i.e., a 95% confidence level).

2.3.1 Low-Level Waste Management Area 1

Water-level measurements for this study have been periodically collected at LLWMA-1 since September 2005, and the trend-surface analysis results are shown in Table 2-1. The results of the statistical test are given as the *p*-value, which is the probability that a spatially dependent trend is not actually present in the data. Where this value is less than 0.05, the trend-surface analysis result is deemed statistically significant.

3 A misclosure value is the difference in elevation between the starting and ending values of a survey loop that closes on the starting point. Ideally, the misclosure value should be zero, but this is rarely achieved because measurements always have some uncertainty. Thus, the misclosure value provides an indication of the uncertainty in a survey loop. Small misclosure values indicate high accuracy. The misclosure is typically distributed linearly throughout the survey loop to determine final elevations.

Eleven sets of water-level measurements were collected at LLWMA-1 from September 2005 through June 2008, and all but two of the measurements yielded a statistically significant result, indicating a gradient direction between northwest and north (Table 2-1). The *p*-values for the two data sets not deemed statistically significant were 0.060 and 0.070, which are only slightly above 0.05. Using all of the trend-surface analysis results, the average hydraulic gradient magnitude during this time was 8.2 x 10^{-6} m/m (±0.7 x 10^{-6} m/m) and the average direction was north-northwest at 338 degrees azimuth (±9 degrees). This interpretation agrees with the orientation of contaminant plumes emanating from nearby Waste Management Area B-BX-BY and the BY Cribs.

At LLWMA-1 in the northwestern portion of the 200 East Area, the long-term groundwater flow direction is toward the north-northwest, although temporary flow reversals can occur due to seasonal changes in Columbia River stage.

The collection of monthly water-level measurements began at LLWMA-1 during June 2008, and beginning in July 2008, the hydraulic gradient results began to change. The results in July 2008 were not statistically significant with a very high *p*-value (Table 2-1). During August, September, and October, the results were statistically significant, with southerly flow directions for all 3 months. Although the results for November and December were not statistically significant, southerly directions were indicated with only moderately high *p*-values. During January, February, and March 2009, the results were not statistically significant with very high *p*-values. Indications of a northern direction began again during April and May with moderately high *p*-values, and finally a statistically significant northern direction was indicated for July 2009. These results indicate that a temporary reversal in groundwater flow direction occurred, with southerly flow occurring from August through October 2008, and perhaps into December. The months with high *p*-values, (i.e., July 2008 and January, February, and March 2009) indicate periods of transition between northern and southern flow.

Previous work has suggested that in addition to the long-term decline in water levels due to the reduction of effluent discharges at the Hanford Site, the water table elevation in the 200 East Area is potentially affected by two other stressors: seasonal changes in Columbia River stage, and discharges to the TEDF east of the 200 East Area (see Section 2.1.1 and also PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*). It is feasible for changes in Columbia River stage to affect the water table in the 200 East Area because the aquifer in this area and to the north through Gable Gap is highly transmissive. The two stressors are expected to have opposite effects on the hydraulic gradient at LLWMA-1. Because the TEDF is located southeast of LLWMA-1, discharges to the TEDF should increase the magnitude of the northward hydraulic gradient. In contrast, river stage effects propagating inland from the north should decrease the northward gradient or cause a gradient reversal at LLWMA-1. The flow reversal documented at LLWMA-1 appears to be a result of high Columbia River stage during the summer of 2008 combined with the lack of large volume discharges to the TEDF during that year.

2.3.2 Integrated Disposal Facility/PUREX Cribs

At the second site, the IDF/PUREX Cribs, water-level measurements have been collected for this study since June 2008. The measurements at this site exhibit more variability compared to LLLWMA-1. Many of the wellbores at IDF/PUREX Cribs are more substantially deviated from vertical. This results in more friction when a measuring tape is lowered into the well, which makes obtaining an accurate depth-to-water measurement more difficult. In addition, field observations indicate a greater amount of air movement through the wellbores in response to atmospheric pressure changes than has been observed at LLWMA-1, so water-level changes caused by barometric pressure fluctuations may be greater. A method for normalizing water-level data for barometric pressure fluctuations in 200 East Area wells is currently being developed.

The trend-surface analysis results for IDF/PUREX Cribs are provided in Table 2-2. When all of the wells were used in the trend-surface analyses, statistically significant results were not obtained for any set of measurements. To obtain the results shown in Table 2-2, each data set was analyzed by repeatedly removing the well with the highest residual (i.e., the measurement having the largest difference from the fitted plane) until the dip direction stabilized and the trend-surface result was statistically significant. The resulting hydraulic gradient directions range from northeast (29 degrees azimuth) to south (173 degrees azimuth). The average direction was east at 82 degrees (±21 degrees), and the average gradient magnitude was 2.1 x 10^{-5} m/m (±0.3 x 10^{-5} m/m). The average gradient magnitude is in close agreement with the estimated regional gradient magnitude of ~1.5 x 10^{-5} m/m (Section 2.1), and the average direction is in reasonable agreement with previous interpretations of east to southeast flow based on the geometry of contaminant plumes (DOE/RL-2008-66).

At the Integrated Disposal Facility/ PUREX Cribs in the southeastern portion of the 200 East Area, water-level data indicate that the groundwater flow direction is toward the east.

In summary, the hydraulic gradient was successfully measured at LLWMA-1, and reasonable results were also obtained at the IDF/PUREX Cribs. The long-term, average groundwater flow direction at LLWMA-1 is to the north-northwest, although temporary flow reversals occur during some years and are attributed to seasonal changes in Columbia River stage. The flow direction at the IDF/PUREX Cribs is apparently eastward. Both of these results show agreement with previous flow interpretations based on the geometry of nearby contaminant plumes.

2.3.3 Low-Level Waste Management Area 2

Efforts to determine the hydraulic gradient at a third location in the 200 East Area, the LLWMA-2/216-B-63 Trench, began during the spring of 2009. A network of fourteen wells was established, and gyroscope and casing elevation surveys were performed. The collection of water-level measurements began during March 2009, and the data are currently being evaluated. It is too early in the study to determine a hydraulic gradient, but data collection and evaluation will continue at this site during calendar year 2010.

Table 2-1. Hydraulic Gradient Determinations for Low-Level Waste Management Area 1.

Measurement Date	Gradient Magnitude (m/m)	Gradient Direction (Azimuth)[a]	p-Value[b]	Statistically Significant
Ten-Well Network				
9/1/2005	7.7×10^{-6}	312	0.020	Yes
9/12/2005	8.2×10^{-6}	329	0.017	Yes
10/11/2005	8.0×10^{-6}	356	0.005	Yes
10/25/2005	6.4×10^{-6}	320	0.060	No
11/23/2005	6.9×10^{-6}	336	0.017	Yes
12/29/2005	1.0×10^{-5}	13	0.014	Yes
2/2/2006	9.7×10^{-6}	350	0.011	Yes
3/8/2006	7.8×10^{-6}	332	0.070	No
6/8/2006	1.0×10^{-5}	347	0.009	Yes
1/25/2007	7.3×10^{-6}	336	0.015	Yes
Fourteen-Well Network				
6/16/2008	8.1×10^{-6}	324	0.005	Yes
Mean (through June 2008)	8.2×10^{-6} ($\pm 0.7 \times 10^{-6}$)	338 (±9)		
7/21/2008	1.3×10^{-6}	97	0.964	No
8/29/2008	1.3×10^{-5}	213	0.004	Yes
9/11/2008	9.3×10^{-6}	156	0.001	Yes
10/23/2008	1.1×10^{-5}	226	0.038	Yes
11/26/2008	1.1×10^{-5}	225	0.127	No
12/23/2008	5.7×10^{-6}	160	0.289	No
1/12/2009	8.9×10^{-7}	130	0.945	No
2/23/2009	5.3×10^{-6}	149	0.516	No
3/24/2009	6.3×10^{-7}	106	0.974	No
4/13/2009	4.7×10^{-6}	316	0.271	No
5/28/2009	8.2×10^{-6}	310	0.234	No
7/17/2009	2.0×10^{-5}	335	0.013	Yes
9/21/2009	3.7×10^{-6}	8	0.573	No
10/27/2009	6.0×10^{-6}	100	0.578	No

Notes:
a. Degrees clockwise from true north; 90 = east, 180 = south, 270 = west, 0 and/or 360 = north.
b. The probability that there is no spatially dependent trend in the water-level measurements. If the *p*-value is less than 0.05, the fitted trend surface is deemed statistically significant.

Table 2-2. Hydraulic Gradient Determinations for Integrated Disposal Facility/ PUREX Cribs.

Measurement Date	Gradient Magnitude (m/m)	Gradient Direction (azimuth)[a]	*p*-Value[b]	Statistically Significant	Number of Wells[c]
6/16/2008	1.7×10^{-5}	61	0.012	Yes	9
8/1/2008	2.9×10^{-5}	149	0.004	Yes	8
8/29/2008	2.1×10^{-5}	59	0.007	Yes	8
9/11/2008	2.7×10^{-5}	173	0.001	Yes	7
10/23/2008	2.3×10^{-5}	52	0.026	Yes	7
11/26/2008	1.1×10^{-5}	102	0.007	Yes	5
12/22/2008	1.3×10^{-5}	91	0.043	Yes	7
1/26/2009	1.6×10^{-5}	115	0.006	Yes	7
2/5/2009	2.0×10^{-5}	51	0.008	Yes	8
3/24/2009	2.0×10^{-5}	46	0.014	Yes	8
6/29/2009	2.4×10^{-5}	29	0.010	Yes	5
9/22/2009	2.7×10^{-5}	54	0.011	Yes	8
Mean	2.1×10^{-5} ($\pm 0.3 \times 10^{-5}$)	*82 (±21)*			

Notes:
a. Degrees clockwise from true north; 90 = east, 180 = south, 270 = west, 0 and/or 360 = north.
b. The probability that there is no spatially dependent trend in the water-level measurements. If the *p*-value is less than 0.05, the fitted trend surface is deemed statistically significant.
c. There are 11 wells in the Integrated Disposal Facility/PUREX water-level network, but to achieve statistically significant trend surface results, wells with the highest residuals were removed in sequence until a statistically significant result was achieved and the gradient direction stabilized.
PUREX = Plutonium-Uranium Extraction (Plant)

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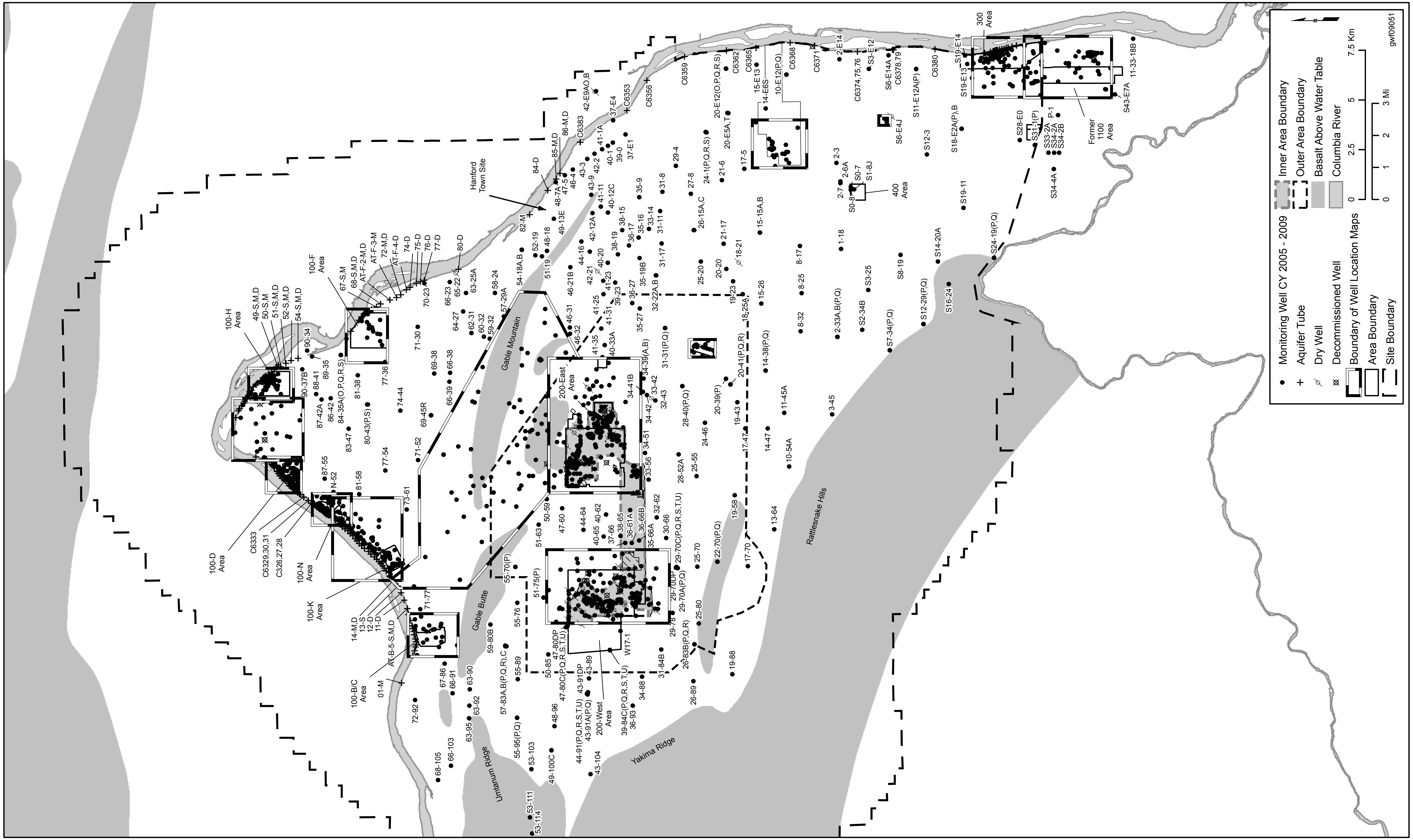

Figure 2-1. Groundwater Monitoring Wells on the Hanford Site.

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Figure 2-2. Hanford Site Water Table Map, March 2009

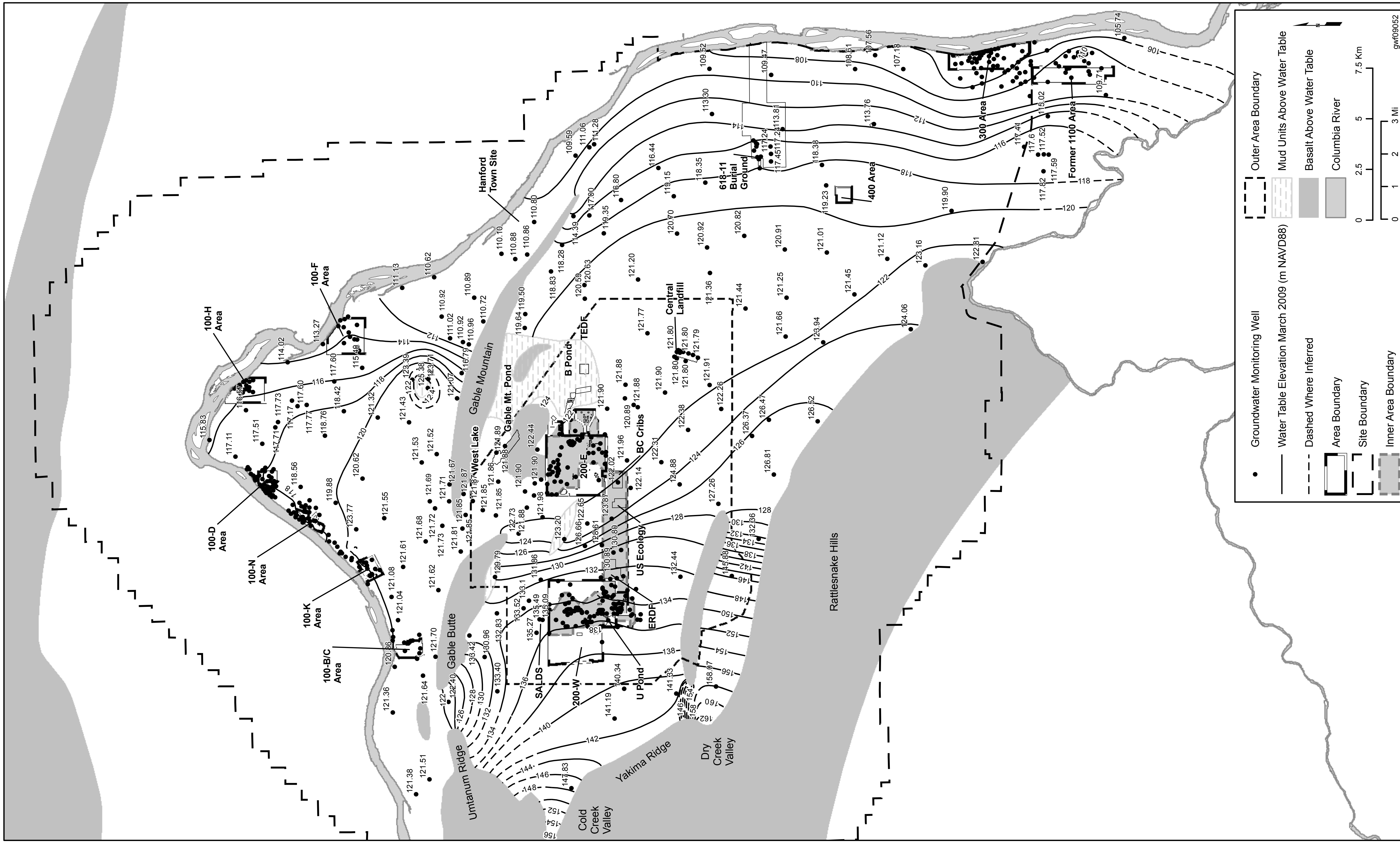

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Figure 2-3. 200 East Area Water Table Elevations, Calendar Years 2008 and 2009.

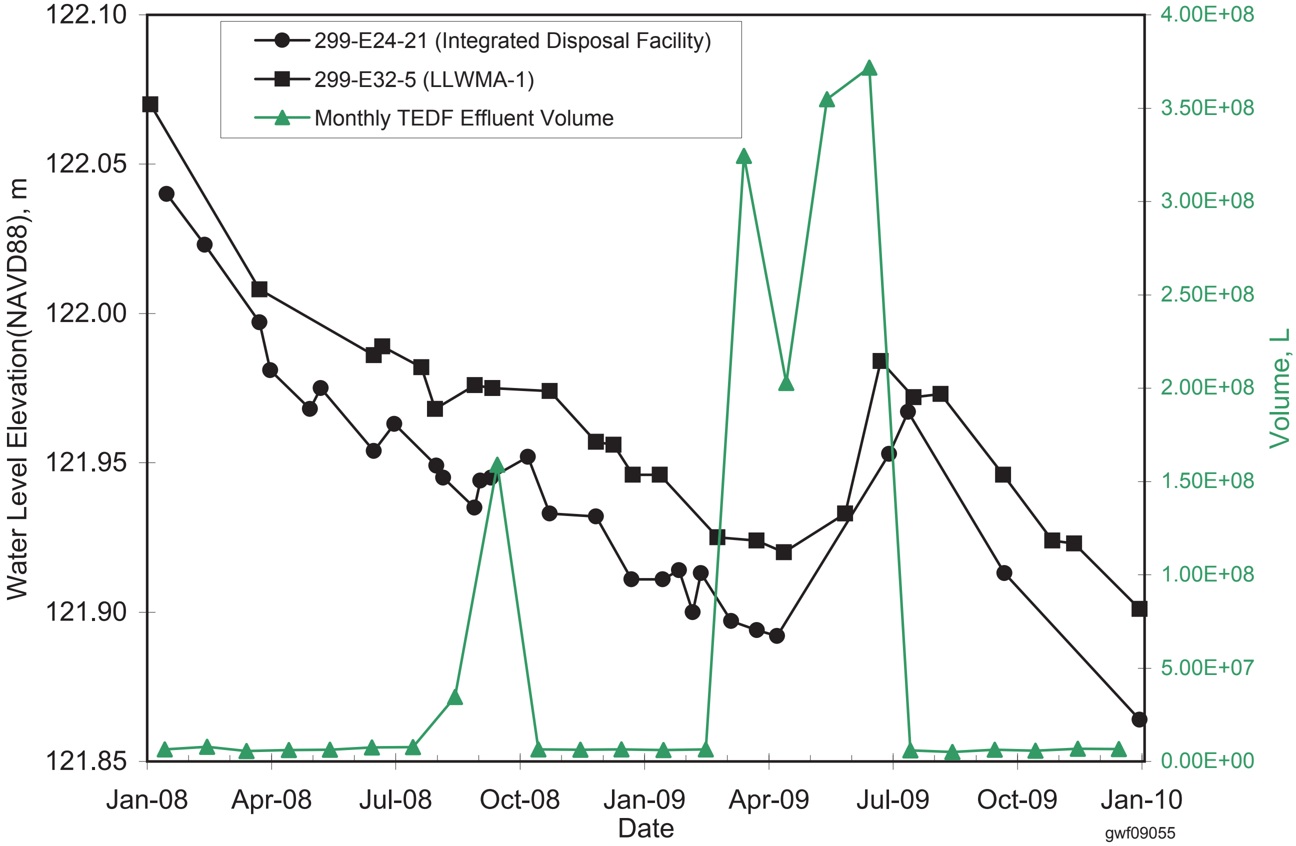


Figure 2-4. Low-Level Waste Management Area 1 Water-Level Monitoring Well Network.

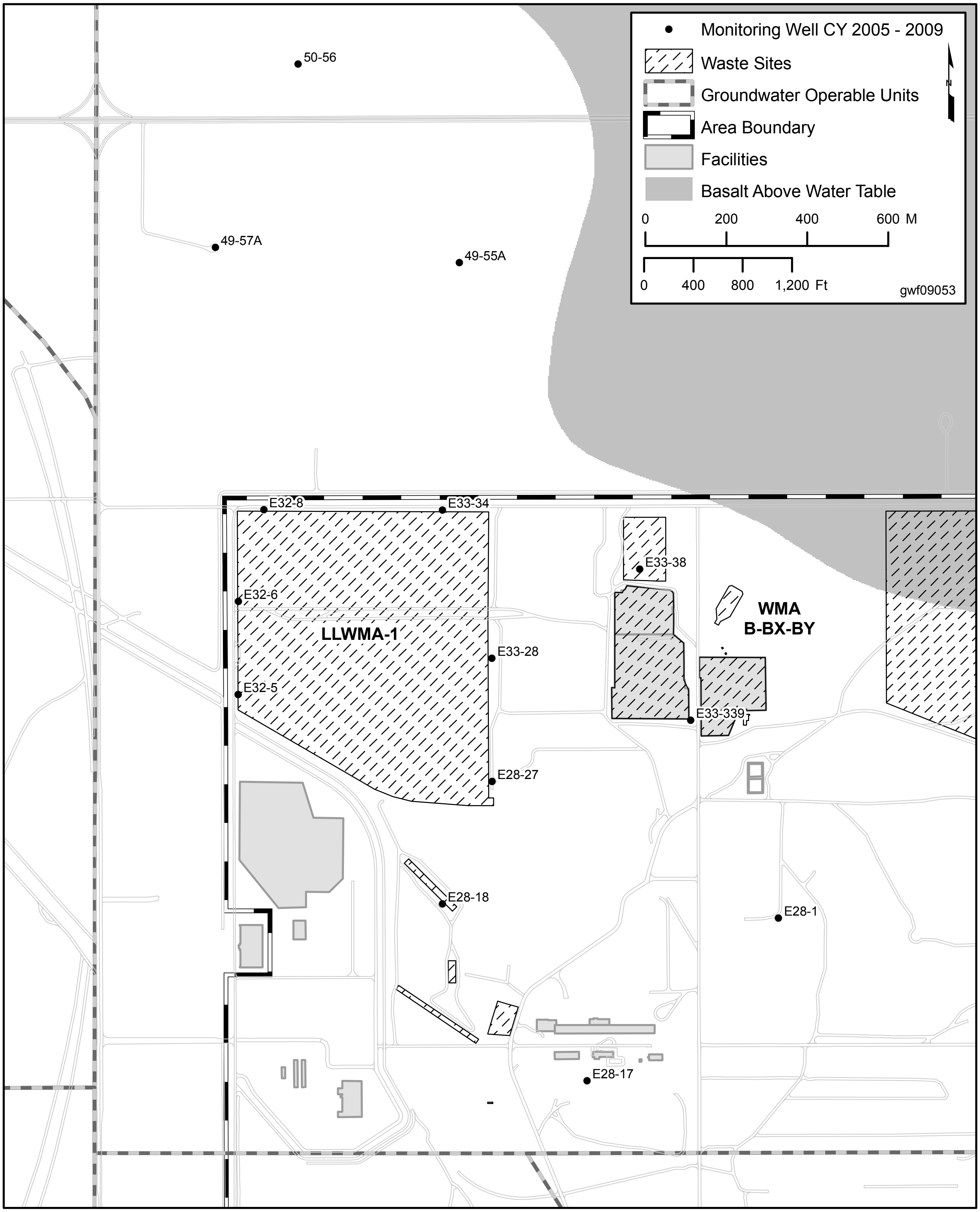
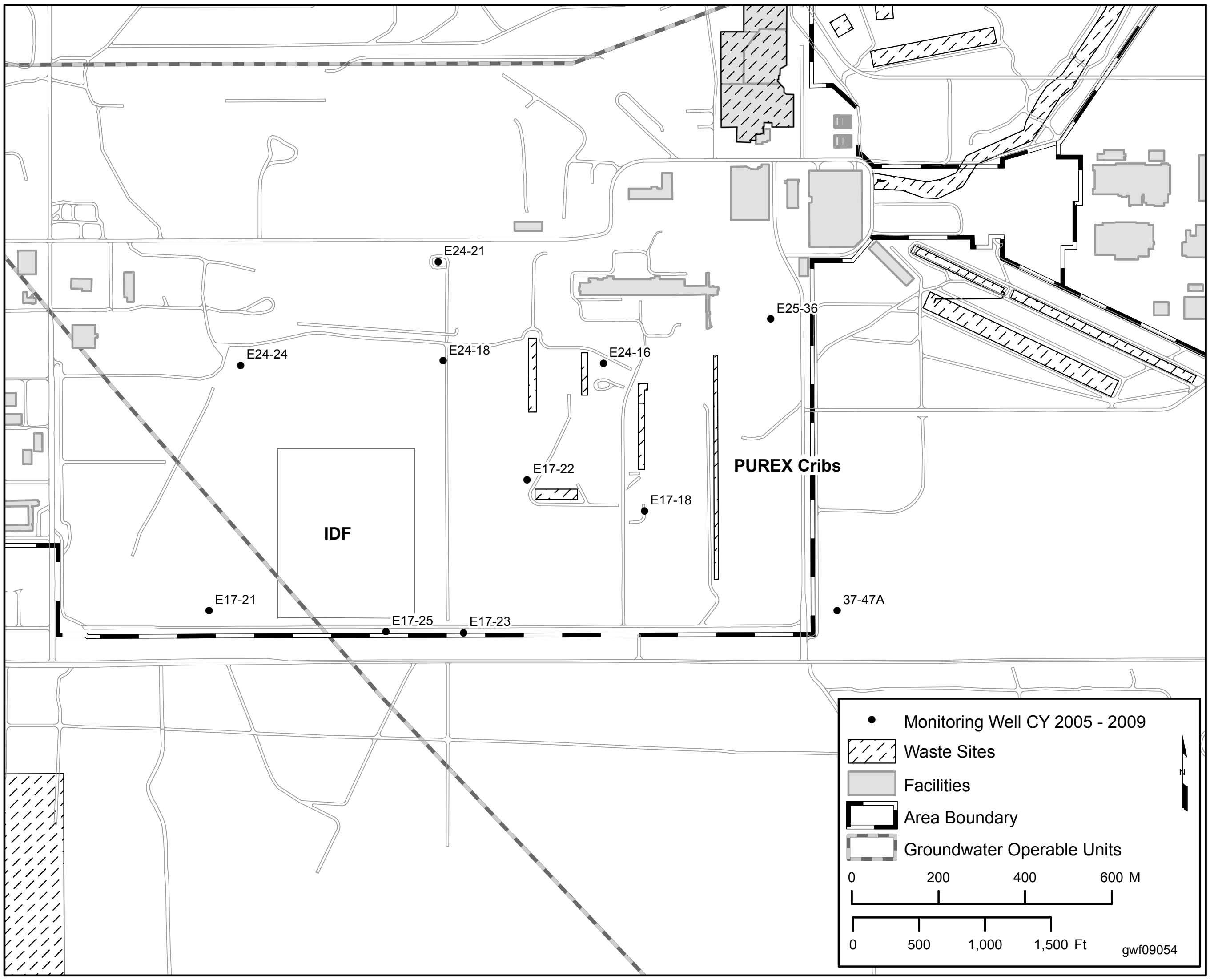


Figure 2-5. Integrated Disposal Facility/PUREX Cribs Water-Level Monitoring Well Network.



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