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Water-Level Monitoring Plan for the Hanford Groundwater Monitoring Project

J. P. McDonald
M. A. Chamness
D. R. Newcomer

September 1999

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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Executive Summary

This document presents the water-level monitoring plan for the Hanford Groundwater Monitoring Project, conducted by the Pacific Northwest National Laboratory (PNNL). Water-level monitoring of the groundwater system beneath the Hanford Site is performed to fulfill the requirements of various state and federal regulations, orders, and agreements. The primary objective of this monitoring is to determine groundwater flow rates and directions. To meet this and other objectives, water-levels are measured annually in monitoring wells completed within the unconfined aquifer system, the upper basalt-confined aquifer system, and in the lower basalt-confined aquifers for surveillance monitoring. At regulated waste units, water levels are taken monthly, quarterly, semi-annually, or annually, depending on the hydrogeologic conditions and regulatory status of a given site.

The techniques used to collect water-level data are described in this document, along with the factors that affect the quality of the data and the strategies employed by the project to minimize error in the measurement and interpretation of water levels. Well networks are presented for monitoring the unconfined aquifer system, the upper basalt-confined aquifer system, and the lower basalt-confined aquifers, all at a regional scale ("surveillance" monitoring), as well as the local-scale well networks for each of the regulated waste units studied by this project ("regulated-unit" monitoring). The criteria used to select wells for water-table monitoring are discussed. It is observed that poor well coverage for surveillance water-table monitoring exists south and west of the 200-West Area, south of the 100-F Area, and east of B Pond and the Treated Effluent Disposal Facility (TEDF). This poor coverage results from a lack of wells suitable for water-table monitoring, and causes uncertainty in representation of the regional water-table in these areas. These deficiencies are regional in scale and apply to regions outside of the operational areas, so these deficiencies do not in any way reflect on the adequacy of the local-scale well networks used for regulated-unit monitoring.

The sediments comprising the unconfined aquifer system have been subdivided into nine hydrogeologic units. The specific hydrogeologic units present within the saturated open interval of each onsite well used for water-level measurements are identified. This was accomplished by geologic interpretation at individual wells combined with extrapolation to nearby wells using a three-dimensional, regional-scale conceptual model of the Hanford Site hydrostratigraphy.

Acknowledgments

This document benefited from the contributions and reviews of several individuals. Frank Spane was the lead technical reviewer and provided valuable comments to improve the quality of the manuscript. Technical review of the entire manuscript also was performed by Mickie Chamness, Darrell Newcomer, Bruce Williams, and Stuart Luttrell. Additional comments were also provided by Marcel Bergeron, Signe Wurstner, Marvin Furman, and Doug Hildebrand. Launa Morasch performed the editorial review and managed the final production and publication process. Word processing support was provided by Kathy Neiderhiser.

Paul Thorne performed the conceptual model extrapolations of the Hanford Site hydrostratigraphy used in assigning specific hydrogeologic units to individual monitoring wells. Paul also provided the extent of each hydrogeologic unit beneath the water table used in Figures 3.7 through 3.14, also from the conceptual model. The recent hydrogeologic interpretations were performed by Bruce Williams and Mickie Chamness. Signe Wurstner provided the effective screened intervals used in the hydrogeologic unit assignments.

Finally, the contributions of William Webber and Darrell Newcomer are recognized. Their insights regarding the water-level monitoring data collection and analysis techniques used by this project, which were obtained through many informal discussions over the past years, have been of valuable assistance and are much appreciated.

John P. McDonald
September 1999

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1.0 Introduction

The U.S. Department of Energy's (DOE) Hanford Site occupies 1,450 square kilometers of land along the Columbia River in south-central Washington State (Figure 1.1). The site was established in 1943 with the primary mission of producing special nuclear materials for the national defense. The operational areas on the Hanford Site where production activities were conducted are shown in Figure 1.2, along with other prominent features and facilities on and adjacent to the site. In the late 1980s, production of special nuclear materials ceased and Hanford's mission was changed to environmental cleanup.

The Hanford Groundwater Monitoring Project ("groundwater project"), conducted by the Pacific Northwest National Laboratory (PNNL), routinely collects groundwater samples, measures water levels in groundwater wells, and conducts aquifer characterization activities at the Hanford Site to fulfill a variety of state and federal regulations. The objectives of this work are to (1) maintain and verify compliance with all applicable groundwater regulations, (2) define the hydrogeologic, physical, and chemical trends in the groundwater system, (3) establish baselines of groundwater quality, (4) provide an independent assessment of groundwater remediation activities, and (5) identify and quantify new and existing groundwater problems (DOE 1997). This document represents the water-level monitoring plan for the groundwater project. See Hartman et al. (1998) for an integrated monitoring plan addressing groundwater sampling activities.

1.1 Purpose and Scope of This Plan

The purpose of this plan is to document the water-level monitoring strategy and activities to support the groundwater project. The primary focus is on the regional groundwater system beneath and adjacent to the Hanford Site, but localized water-level monitoring conducted by the groundwater project at regulated waste units is also summarized for completeness.

The specific objectives of this plan are to

- provide users of water-level information with a detailed description and justification for the water-level monitoring program
- identify wells within the water-level monitoring network
- describe the criteria used to select wells for water-level monitoring
- list the frequency and timing of water-level measurements and the considerations used to make these determinations
- provide the best information currently available regarding the specific hydrogeologic unit(s) monitored by each well
- describe the procedures and associated quality assurance requirements used to collect water-level data
- describe how water-level data are analyzed and reported.

This document is applicable only to the water-level monitoring activities of the Hanford Groundwater Monitoring Project. Many of the water level-data collection activities carried out under this project are subcontracted to Waste Management Federal Services, Inc., Northwest Operations (WMNW). Water-level monitoring activities are also carried out separate from the groundwater project by the Environmental Restoration Contractor (ERC), Bechtel Hanford, Inc. (BHI), as part of cleanup investigations.

1.2 Water-Level Monitoring Objectives

The unconfined aquifer beneath the Hanford Site is contaminated with both radionuclides and hazardous chemicals at concentrations above drinking water standards. The volume of contaminated groundwater is estimated to be about 1.4 billion cubic meters (Hartman 1999). The extent of radionuclides and hazardous chemicals in the groundwater are shown in Figures 1.3 and 1.4, respectively. The primary reason for collecting water-level data is to determine the direction and rate of groundwater flow in order to interpret observed contaminant plume patterns and to assess the potential for future plume movement. Thus, the collection and analysis of water-level data supports the objectives of the groundwater project, specifically that of defining the hydrogeologic, physical, and chemical trends in the groundwater system.

Other objectives of water-level data analysis include

1. the identification of recharge and discharge areas
2. assessing the interaction between groundwater and surfacewater bodies
3. assessing the interaction between individual aquifers or hydrogeologic units
4. calibration of groundwater flow models
5. assessing the impact of liquid-effluent disposal practices on groundwater flow
6. assessing the impact of groundwater pump-and-treat operations on localized groundwater flow patterns
7. assessing the effect of water-level and flow-direction changes on the suitability of well networks used for groundwater quality sampling. All of these are objectives of the water-level monitoring program.

Water-level monitoring is performed also to either directly or indirectly fulfill the requirements of several higher-level planning documents, as well as various state and federal regulations, orders, and agreements. The *Atomic Energy Act of 1954* as amended, calls for the U.S. Department of Energy (DOE) to conduct its operations in a manner that protects the health and safety of the public and the environment. DOE Order 5400.1 implements this requirement by establishing an environmental protection program to assure compliance with applicable federal, state, and local regulations. This order requires an annual environmental report be prepared that, among other topics, includes a summary of groundwater movement. U.S. Department of Energy, Richland Operations (DOE-RL), prepared an environmental monitoring plan (DOE 1997), pursuant to DOE Order 5400.1, to document the effluent monitoring and environmental surveillance activities conducted at Hanford. This document calls for water-level monitoring to (1) characterize the direction and velocity of groundwater flow, (2) determine the impact of site operations on groundwater flow, and (3) assess the adequacy of point-of-compliance wells to detect groundwater contamination. Water-level monitoring conducted under DOE Order 5400.1 is referred to herein as "surveillance monitoring."

Water-level monitoring is also conducted by the groundwater project at sites regulated by the *Resource Conservation and Recovery Act of 1976* (RCRA), as amended, and three State of Washington Administrative Codes: *Dangerous Waste Regulations* (WAC-173-303) (Washington State's version of

RCRA), *State Waste Discharge Permit Program* (WAC-173-216) and *Minimum Functional Standards for Solid Waste Handling* (WAC-173-304). Water-level monitoring conducted at these regulated sites is referred to herein as "regulated-unit monitoring." The RCRA regulations (40 CFR Part 265, Subpart F and WAC 173-303) require that groundwater elevations beneath regulated sites be evaluated at least annually to assess the ability of groundwater monitoring wells to detect contamination in the uppermost aquifer. If contamination is detected, more frequent water-level measurements may be required to determine the rate and extent of contaminant migration. WAC-173-304 also requires that the rate and direction of groundwater flow in the uppermost aquifer be determined at least annually. Facilities currently operating at Hanford that release liquid effluents to the soil column have permits granted under WAC-173-216. Water-level monitoring conducted at these sites is performed to assess the effect of these effluent releases on the groundwater system.

1.3 Plan Organization

Section 2.0 of this plan provides an overview of the Hanford Site geology and briefly describes the hydrogeologic conditions beneath the site. This section provides the framework for the detailed discussion of specific monitoring networks that follow. Section 3.0 discusses the water-level monitoring program itself, including data collection methods for both manual and automatic measurements, equipment calibration/standardization, and the water-level monitoring networks in use. It also includes identification of well networks for specific hydrogeologic units. Section 4.0 presents data quality issues and requirements, describes how the water-level data is managed and stored, the techniques used to analyze the data, as well as reporting requirements. Cited references are listed in Section 5.0. Finally, Appendix A provides a list of all wells used for water-level monitoring by the groundwater project along with selected attribute information for each well, including the hydrogeologic units present within the saturated open interval for onsite wells.

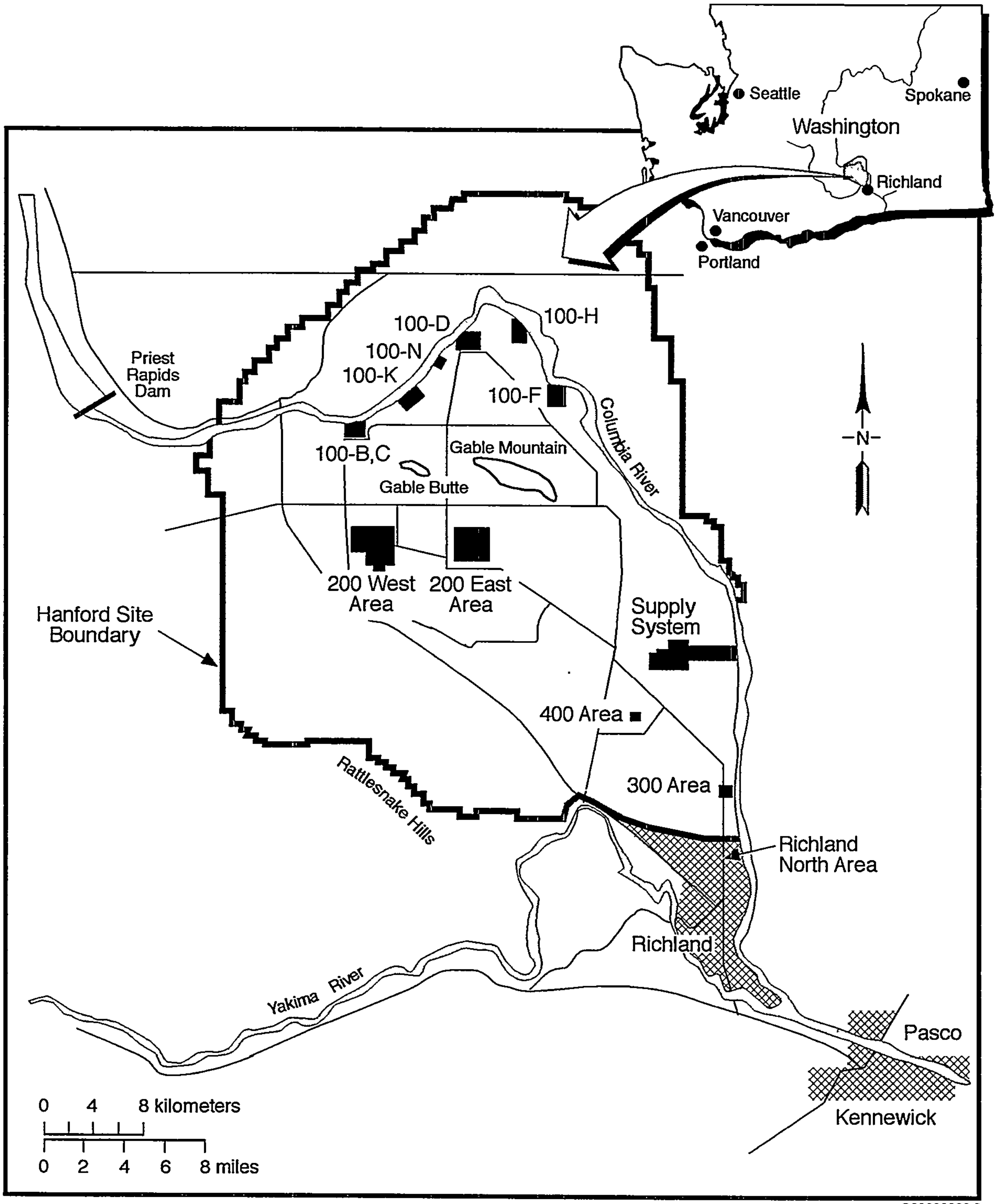

Figure 1.1. Hanford Site Location Map

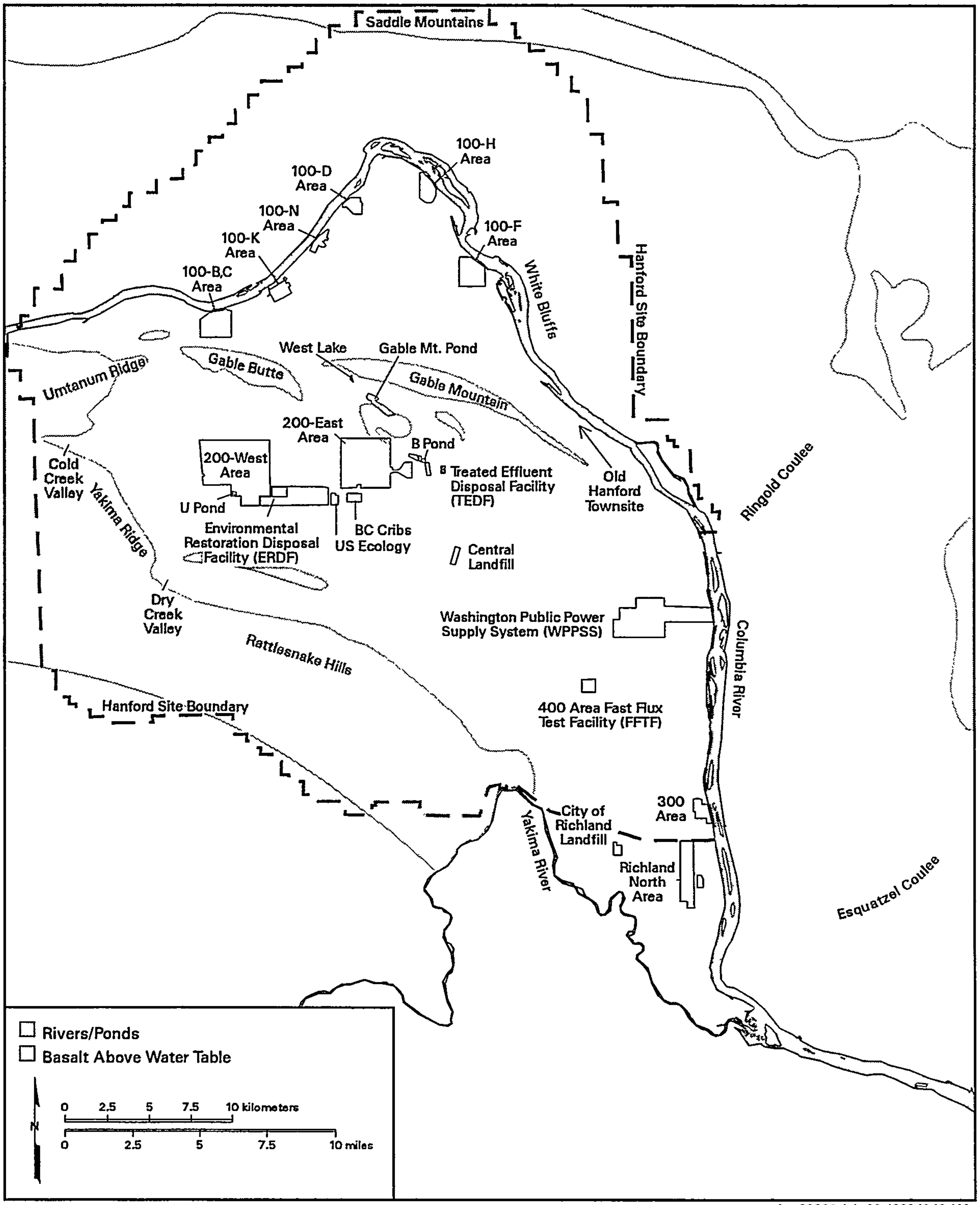

Figure 1.2. Operational Areas and Other Prominent Features on and Adjacent to the Hanford Site

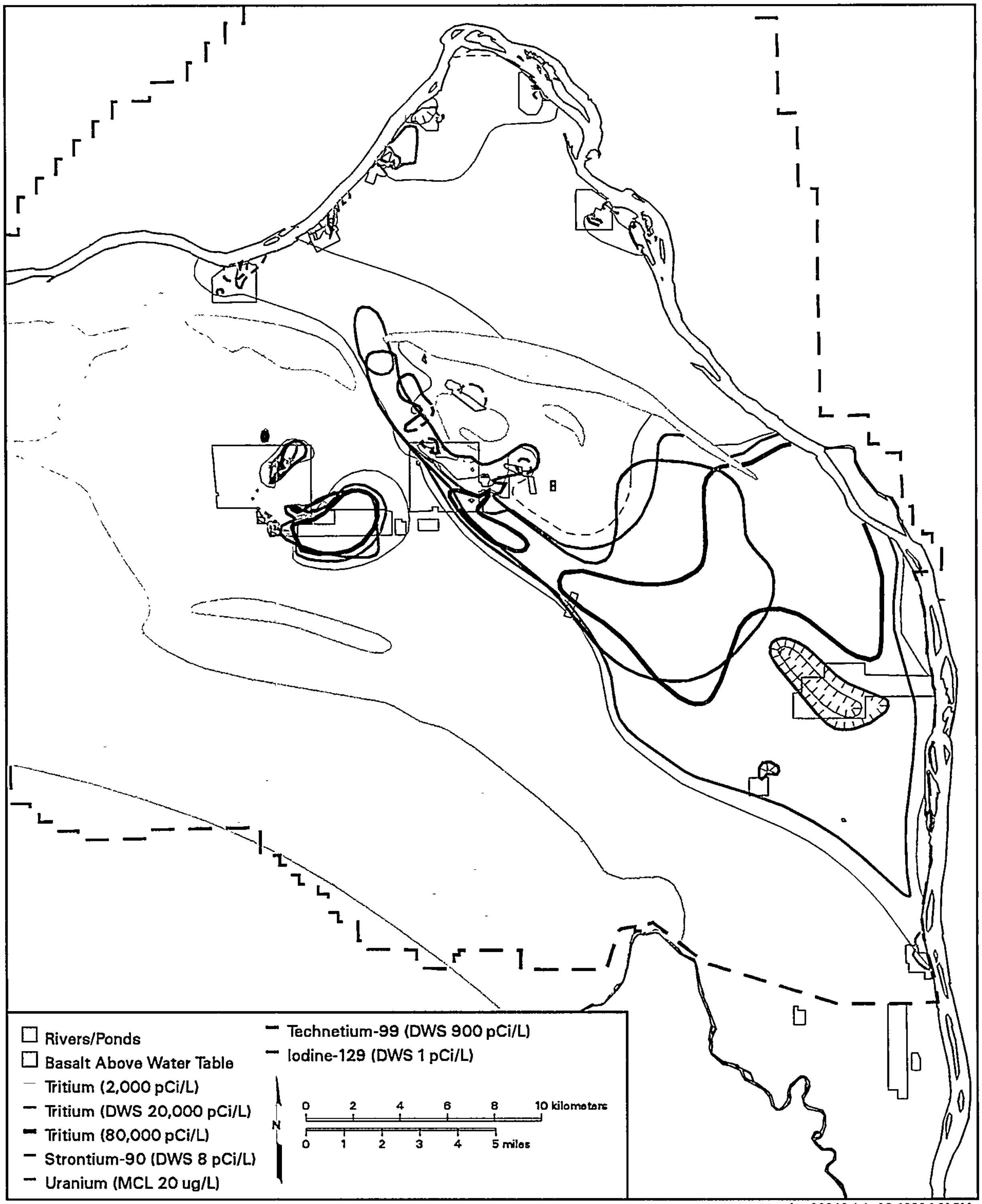

Figure 1.3. Distribution of Major Radionuclides in Groundwater at Concentrations Above Maximum Contaminant Levels or Interim Drinking Water Standards, Fiscal Year 1998

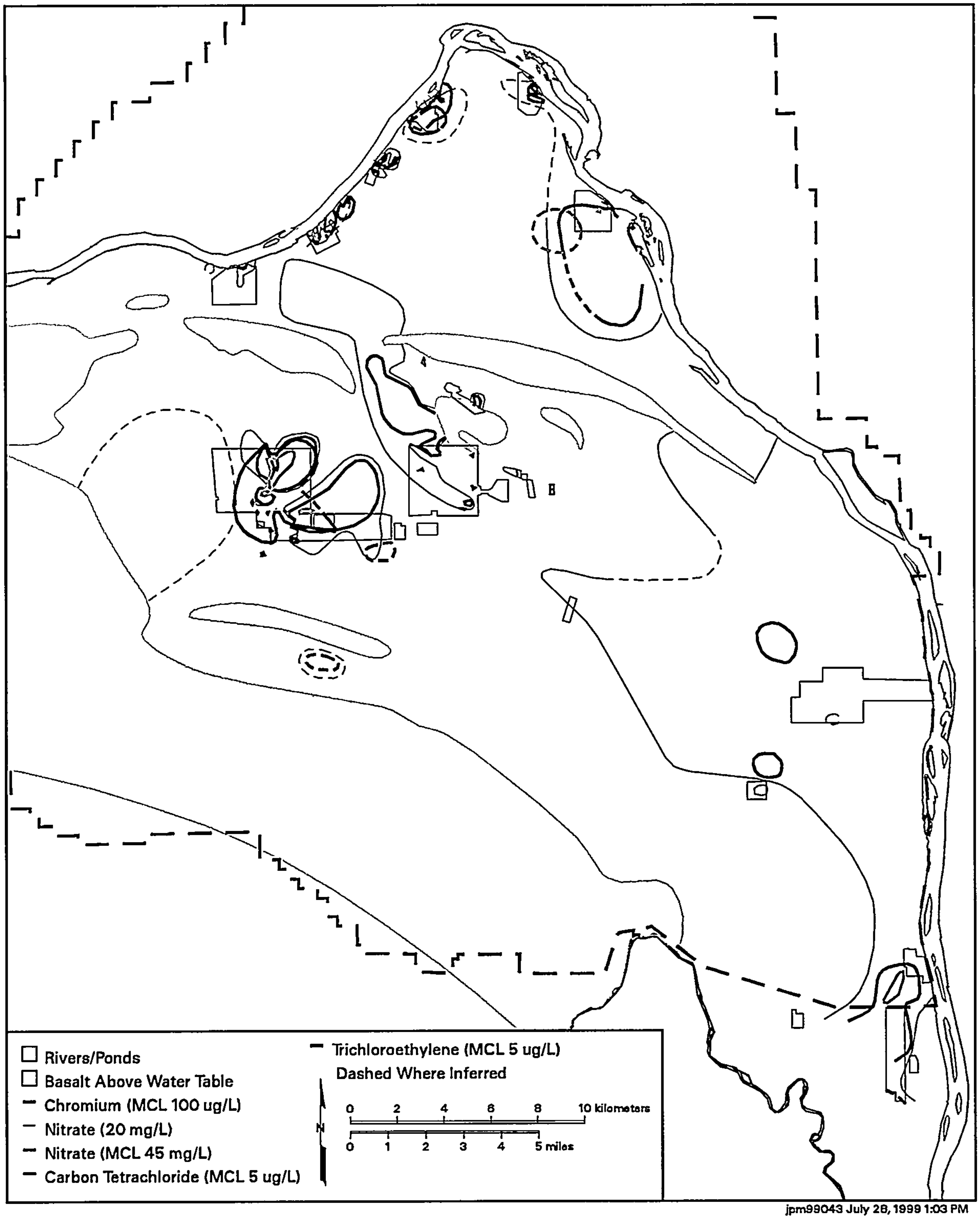

Figure 1.4. Distribution of Major Hazardous Chemicals in Groundwater at Concentrations Above Maximum Contaminant Levels, Fiscal Year 1998

2.0 Hanford Site Hydrogeology

This section provides a brief description of the geologic and hydrogeologic setting for the Hanford Site. The geology and hydrology of the Hanford Site has been reported in numerous studies including DOE (1988) and Lindsey (1995).

2.1 Geologic Setting and Stratigraphy

The Columbia Plateau includes a large portion of eastern Washington and is geologically characterized by a thick sequence of basalt flows known as the Columbia River Basalt Group. As these basalt flows were being erupted, tectonic forces were deforming the land surface into structural and topographic basins and ridges. Between eruptions, sediments were often deposited in the basins, forming interbeds between basalt flows. As the eruption of basalt flows slowed and stopped, a thick sequence of fluvial and lacustrine coarse- and fine-grained sediments were deposited on top of the basalt. Ancient river channels shifted across the basins reworking the coarse-grained channel sediments and depositing fine-grained overbank and lacustrine sediments, forming a complex, interfingered pattern both laterally and vertically. These sediments comprise the Ringold Formation. Subsequent erosion of the Ringold Formation left an irregular surface with a well-developed caliche cap in some places. The caliche and weathering horizon is referred to as the Plio-Pleistocene unit. Catastrophic ice-age floods over the past 700,000 years further eroded existing sediments and deposited the coarse- and fine-grained sediments informally known as the Hanford formation.

The Hanford Site lies within the Pasco Basin, a topographic and structural depression in the Columbia Plateau surrounded by ridges of basalt. Ringold and Hanford Formation sediments are generally thickest in the center of the basin, thinning out laterally against the ridges. The most complete section of the Ringold Formation is in the center of the Pasco Basin, where the basin was subsiding as sediments were deposited. The Ringold Formation is generally more coarse-grained south of Gable Mountain and finer-grained to the north, indicating the ancestral Columbia River channel tended to run between Gable Mountain and Gable Butte. Coarse-grained Hanford formation sediments fill channels eroded into the Ringold Formation sediments in the vicinity of the 200-East Area, where the uppermost basalt flow is near the surface. In the Pasco Basin, the Hanford formation is primarily coarse-grained in the central portion, grading to fine-grained silt and sand near the margins of the basin.

2.2 Groundwater Occurrence

Groundwater beneath the Hanford Site occurs in unconfined and confined conditions. The unconfined aquifer system is defined as all groundwater in the unconsolidated to semi-consolidated sediments of the Hanford and Ringold Formations (i.e., sediments above basalt bedrock) and in the porous top of the uppermost basalt flow (Figure 2.1). In some areas, groundwater within the lower Ringold Formation is locally confined by low-permeability mud layers. Groundwater also occurs within the underlying Columbia River Basalt Group in relatively permeable basalt flow contacts and sedimentary interbeds, and is confined by the relatively dense inner portions of basalt flows. The upper basalt-confined aquifer system is defined as all groundwater within the Levey and Rattlesnake Ridge Interbeds, and within interflow contacts of the Elephant Mountain and Ice Harbor Members of the Saddle

Mountains Basalt (Figure 2.1). Aquifers in the Columbia River Basalt Group beneath the upper basalt-confined aquifer system are collectively referred to as the lower basalt-confined aquifers.

The water-table map for the unconfined aquifer system beneath Hanford and in outlying areas north and east of the Columbia River is shown in Figure 2.2. Beneath the Hanford Site, groundwater within the unconfined aquifer system generally flows from west to east, discharging to the Columbia River. Hydraulic gradients are relatively steep in the western portion of the Site, are almost flat in the central portion, and then steepen again along the Columbia River. This gradient pattern is caused primarily by changes in the permeability of the sediments that comprise the unconfined aquifer system - the highly permeable gravel units of the Hanford Formation occur primarily in the central portion of the site. Sources of recharge to the unconfined aquifer system include (1) precipitation and irrigation runoff from elevated areas along the western boundary of the site, primarily the Cold Creek and Dry Creek Valleys; (2) infiltration of precipitation; (3) upwelling from the underlying upper basalt-confined aquifer System; (4) influent water from the Yakima River along the southern boundary of the site; (5) influent water from the Columbia River west of the 100-B,C areas; and (6) disposal of liquid wastewater to the soil column.

Water-table elevations in outlying areas north and east of the Columbia River are much higher than on the Hanford Site (up to 150 meters higher), primarily due to irrigation and canal leakage (conveyance losses) in the South Columbia Basin Irrigation District. The water table in this area has experienced a significant increase in elevation (over 150 meters in some areas) since predevelopment times (Drost et al. 1997). Groundwater flow in the outlying areas is controlled by topography and the bedrock geology, with groundwater discharge ultimately to the Columbia River (although locally some groundwater is lost to evapotranspiration). A steep hydraulic gradient occurs along the White Bluffs area (immediately east of the Columbia River) where the water table intersects the land surface, resulting in many groundwater seeps and springs in this area.

A potentiometric-surface map of the upper basalt-confined aquifer system is shown in Figure 2.3. Features depicted in the map include (1) a broad recharge mound extending northeast from the Yakima Ridge to the 200-West Area; (2) a small recharge mound in the vicinity of B Pond, east of the 200-East Area; (3) a hydrogeologic barrier at the mouth of Cold Creek Valley, believed to result from faulting; (4) low hydraulic head in the Umtanum Ridge-Gable Mountain structural area; and (5) high hydraulic head north and east of the Columbia River, associated with recharge from agricultural activities. South of the Umtanum Ridge-Gable Mountain structural area, groundwater flows from west to east across the Hanford Site toward the Columbia River, which represents the regional discharge area for groundwater-flow systems. In the region northeast of Gable Mountain, the potentiometric contours suggest that groundwater flows southwest and discharges primarily to underlying confined aquifer systems in the Umtanum Ridge-Gable Mountain structural area (Spane and Raymond 1993). Therefore, the Columbia River does not represent a major discharge area for upper basalt-confined groundwater in the northern portion of the Hanford Site.

2.3 Hydrogeologic Units

Simply stated, a hydrogeologic unit consists of geologic units having similar hydraulic properties, primarily hydraulic conductivity. The determination of hydrogeologic units is the first step in conceptual model development for groundwater flow models, because these units determine the overall geometry of the problem as well as the specific data needs for the modeling effort. This section describes the hydrogeologic units for both the unconfined aquifer system and the upper basalt-confined aquifer system (although modeling of the latter system is not currently being performed). The method and results of assigning monitoring wells to hydrogeologic units are given in Section 3.3.

2.3.1 Unconfined Aquifer System

Hydraulic conductivity is strongly related to sediment texture, which is a function of particle size distribution (i.e., sorting) and cementation. Wurstner et al. (1995) developed a three-dimensional conceptual model that serves as the primary source for the identification of the hydrogeologic units monitored by unconfined aquifer system wells and reported in Section 3.3. In their model, sedimentary units were differentiated based first on particle size as an indicator of hydraulic conductivity. Subsequently, stratigraphic position, color, and presence of distinctive marker horizons were used to help group similar adjacent sediments into units. Although these units are very similar to the geologic units described in reports such as Lindsey (1995), there are differences that need to be recognized (Figure 2.1). Geologically, a sand layer may be grouped with an overlying silt layer because of their depositional environment and time of deposition. Wurstner et al. (1995) would group that same sand with an underlying sandy gravel unit instead, based on the assumption that the sand has a hydraulic conductivity more similar to a sandy gravel than a silt. Using this method, Wurstner et al. (1995) identified nine distinct hydrogeologic units within the sediments overlying the basalt. Hydraulic conductivity ranges for each of these units is based on aquifer pump tests and occasionally from laboratory permeameter tests.

In the 200-East Area, some of the data are being reinterpreted and different hydrogeologic units assigned to the sediments. Some of these new interpretations have been incorporated here. Discrepancies between the new interpretations and those of Wurstner et al. (1995) could not be resolved at this time. Descriptions of hydrogeologic units comprising the Ringold and Hanford Formations given below are from Wurstner et al. (1995), and are compared to the geologic units described in Lindsey (1995). Figure 2.1 also shows a comparison of the geologic and hydrogeologic units beneath the Hanford Site.

Unit 9 is the lowest sedimentary unit used here. Where present, it lies directly on the basalt and consists of fluvial sand and gravel and generally correlates to Lindsey's Ringold Unit A. Overlying Unit 9 is Unit 8, a relatively extensive mud unit of silt and clay with minor sand and gravel that covers much of the Hanford Site. Unit 8 forms a local confining unit in the sedimentary sequence and corresponds to part of the Lower Mud Sequence of Lindsey (1995). Units 7 and 6 are more complex, being deposited as the river channel frequently shifted position. This shifting produced a complex pattern of interfingered, mainstream gravel and overbank silt and clay sediments. To simplify the conceptual model, Wurstner et al. (1995) defined Unit 7 as the coarse-grained unit immediately overlying Unit 8. Unit 6 is defined as the fined-grained sediments with some interbedded coarse-grained layers overlying Unit 7. Unit 6 forms a local confining unit within the middle of the Ringold Formation. The effects of this confining unit have not yet been fully realized but are of importance, however, because the western boundary of this unit is near or beneath the 200-East Area. Unit 7 corresponds often, but not always, to Lindsey's Units B and D, while Unit 6 roughly corresponds to Lindsey's Unit C and unnamed mud layers (Figure 2.1).

Unit 5 is a fluvial, coarse-grained sequence corresponding to Lindsey's Unit E and covers much of the Hanford Site. There are usually no unique characteristics to help distinguish one Ringold Formation gravel or mud unit from another. If Unit 7 is not present, Units 6 and 8 cannot be readily distinguished and consequently were grouped as Unit 8. Similarly, where mud units are not present, the coarse-grained Units 5, and 7 cannot usually be distinguished and were grouped as Unit 5. Overlying Unit 5 are the fined-grained fluvial and lacustrine sediments of Unit 4, the uppermost unit of the Ringold

Formation. These sediments have been eroded either in part or entirely from much of the Hanford Site and do not extensively intersect the water table. Wurstner et al. (1995) did not distinguish between Units 4 and 6 in the eastern part of the area north of Gable Mountain, and grouped the sediments into Unit 6 in that area. Unit 4 is equivalent to Lindsey's Upper Ringold Unit.

Units 2 and 3 correspond to the early Palouse soil and the Plio-Pleistocene unit, respectively. Both are found only in the western portion of the Hanford Site. The Plio-Pleistocene unit (Unit 3) is a paleosoil horizon containing caliche and side-stream basaltic gravel channels. Calcium carbonate in the paleosoil cemented the sediments as it developed on top of eroded Ringold sediments, creating a caliche zone of low hydraulic conductivity. The caliche appears to intersect the water table in a few places north of the 200-West Area. Where present above the water table, the caliche undoubtedly impedes water movement through the vadose zone. The side-stream gravel channels have a much higher hydraulic conductivity, but are not known to intersect the water table. Unit 2 is defined as eolian silt of limited extent, and does not intersect the water table.

Unit 1 is equivalent to the Hanford formation, which is generally a high permeability sand and gravel unit covering much of the Hanford Site. In most areas where Unit 1 intersects the water table, the sediments are gravels or coarse sands.

Hydraulic conductivity values in sand and gravel units of the Ringold Formation are 10 to 100 times lower than the coarse-grained portions of the Hanford formation. Horizontal hydraulic conductivity for Unit 1 ranges from ~1 meters per day to greater than 10,000 meters per day (Thorne and Newcomer 1992). Horizontal hydraulic conductivity for Units 5, 7, and 9 range from 0.1 to 200 meters per day, and vertical hydraulic conductivity ranges from ~0.001 to 20 meters per day (Wurstner et al. 1995). The few hydraulic conductivity values available for the mud units in the Ringold Formation provide estimates ranging from 0.0003 to 0.09 meters per day. These values are likely at the higher end of the true range because most tests were performed only at sites where some groundwater was produced, and there are zones referred to in drilling logs where groundwater is not produced by these mud units. Test results for Unit 6 indicate a slightly higher hydraulic conductivity overall than Unit 8, probably because of the interbedded sand and gravel layers.

2.3.2 Upper Basalt-Confined Aquifer System

In a sequence of basalt flows, the presence of sedimentary interbeds as well as the size and communication between pores and fractures in the basalt affect the hydraulic conductivity. Groundwater moves laterally within the Columbia River Basalt Group primarily in two ways: (1) through sedimentary interbeds between basalt flows and/or (2) within interflow contacts consisting of the vesicular and fractured (porous) flow tops and flow bottoms of the basalt flows themselves. Most basalt flow interiors are dense and solid, have a very low lateral hydraulic conductivity, and generally act as leaky confining layers due to vertical shrinkage fractures. Hydrogeologic units of the upper basalt-confined aquifer system are defined by stratigraphic nomenclature (e.g. Elephant Mountain Interflow zone and Rattlesnake Ridge Interbed).

Hydrogeologic units for the upper basalt-confined aquifer system are defined to be laterally contiguous, permeable units separated by leaky confining layers. Three primary hydrogeologic units are recognized as important for the lateral transmission of water within this system: the Rattlesnake Ridge Interbed, the Levey Interbed, and the Elephant Mountain Interflow zone (Spane and Vermeul, 1994). The Rattlesnake Ridge Interbed occurs between the Elephant Mountain and Pomona Members of the Saddle Mountains Basalt (Figure 2.1). It is the thickest and most widespread intercalated sedimentary unit within the upper basalt-confined aquifer system. Its thickness ranges from 0 to 33 meters, and it is primarily composed of tuffaceous siltstone and sandstone. Beneath the Hanford Site, the Rattlesnake Ridge Interbed is absent only in the Umtanum Ridge-Gable Mountain structural area. The Levey Interbed occurs between the Elephant Mountain Member and the Ice Harbor Member of the Saddle Mountains Basalt (Figure 2.1), and is present only in the southeastern portion of the Hanford Site. The Elephant Mountain Interflow zone occurs within the Elephant Mountain Member (between the Elephant Mountain and Ward Gap flows) (Figure 2.1), and is present only in the eastern portion of the site.

Spane and Vermeul (1994) report hydraulic testing results for 31 slug and constant-rate pumping tests conducted within the hydrogeologic units of the upper basalt-confined aquifer system. The results show a similar range of transmissivity values for all three units. For approximately 90% of the tests, calculated transmissivity values ranged from 1 to 100 square meters per day, with about 65% of these values between 10 to 100 square meters per day. Spane and Webber (1995) estimated that the groundwater flow velocity from the 200-East Area to the Columbia River within the upper basalt-confined aquifer system ranges between 0.7 and 2.9 meters per year.

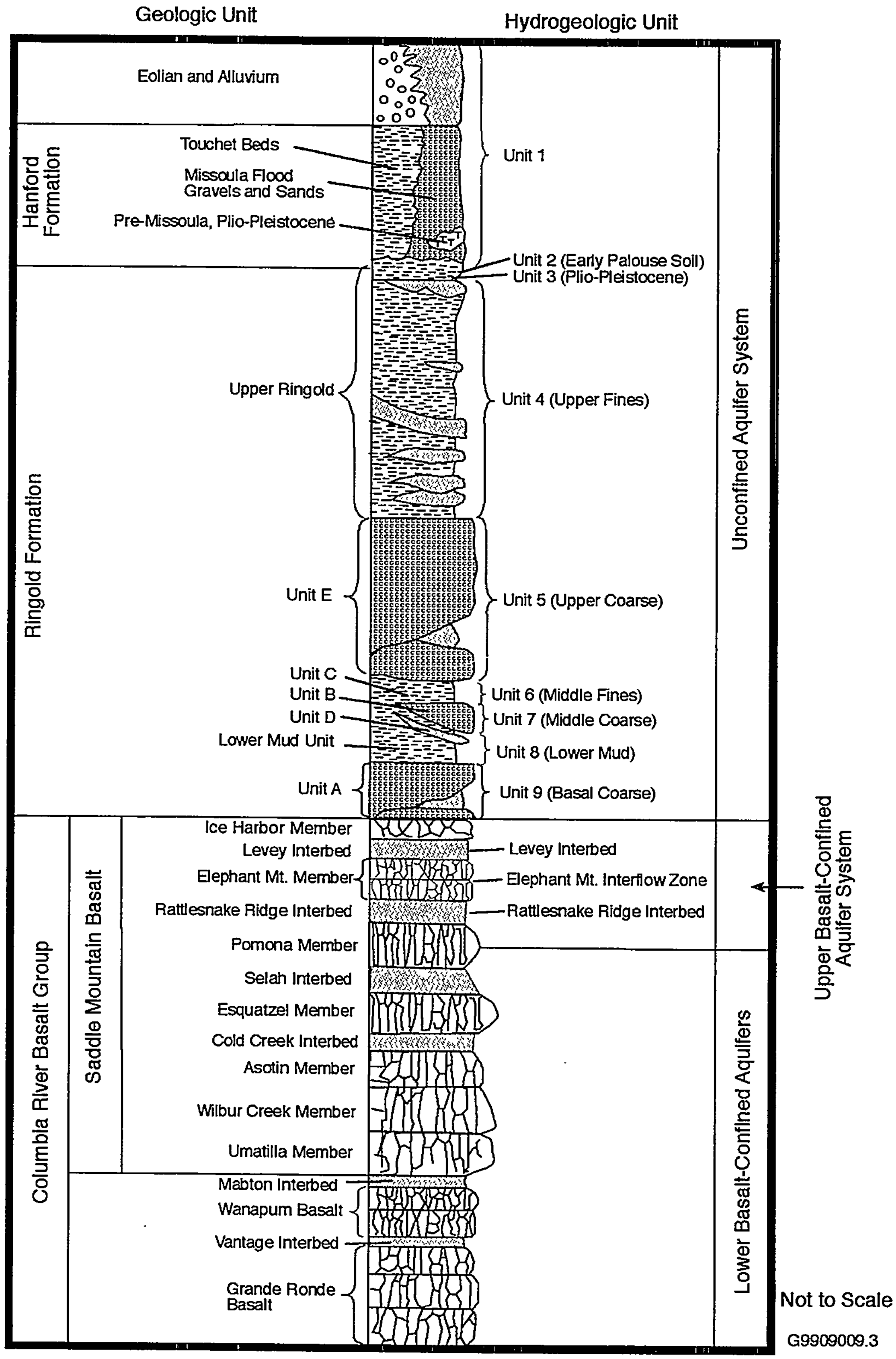

Figure 2.1. Hanford Site Stratigraphy Showing Designated Geologic Units, Hydrogeologic Units, and Aquifer Systems

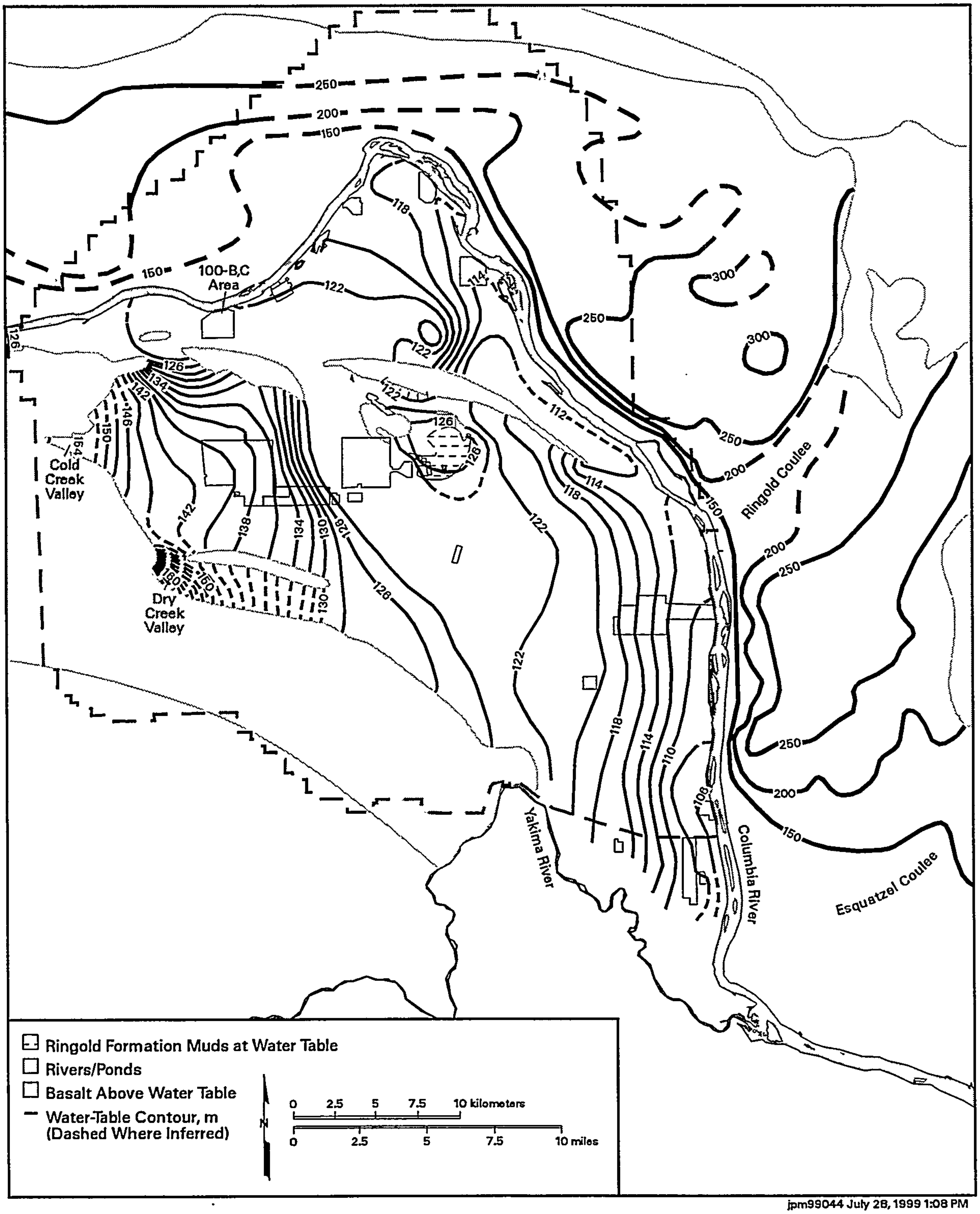

Figure 2.2. Hanford Site and Outlying Areas Water-Table Map, June 1998

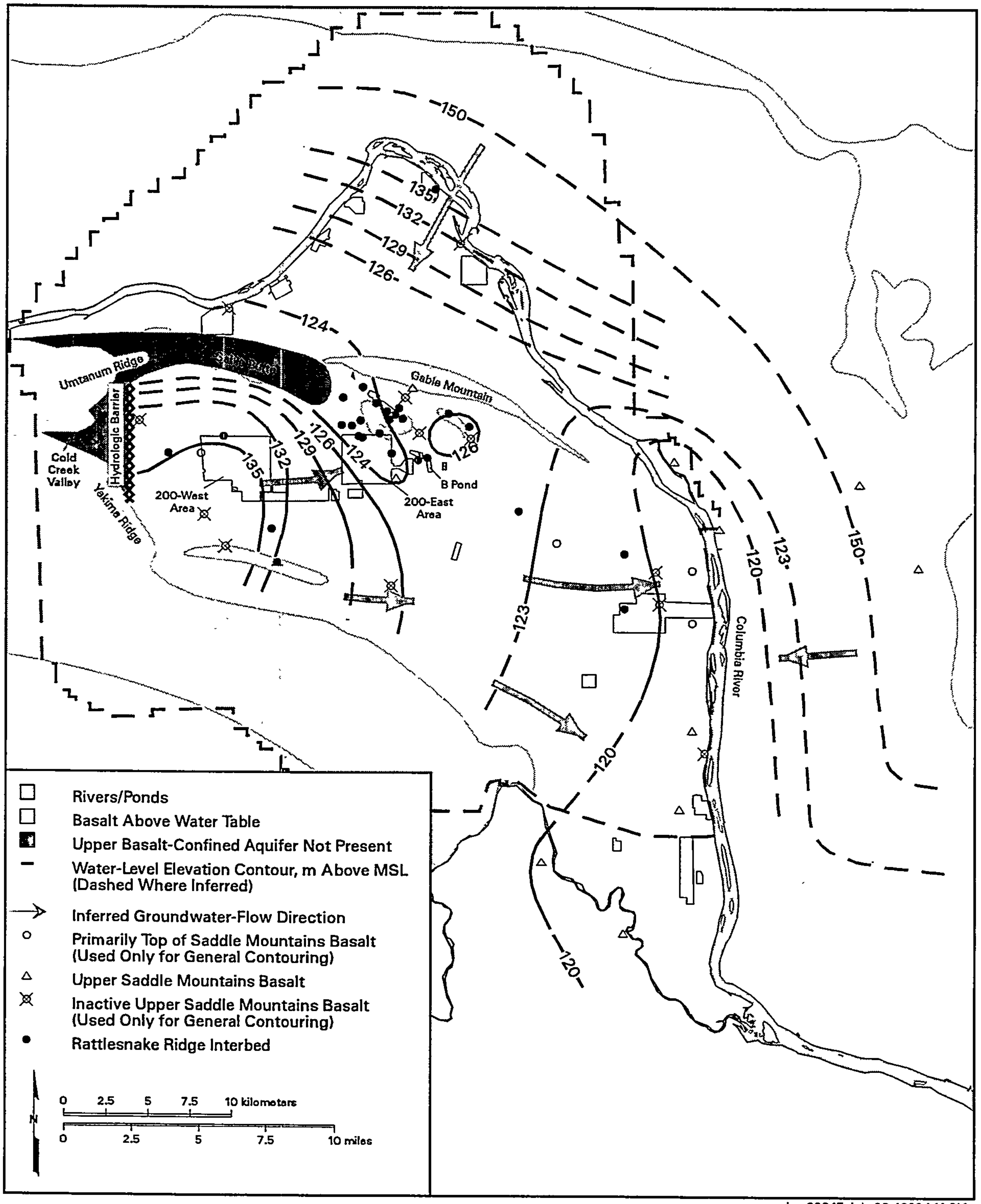

Figure 2.3. Potentiometric-Surface Map for the Upper Basalt-Confined Aquifer System, June 1998

3.0 Water-Level Monitoring Program

Water levels are measured annually in monitoring wells completed within the unconfined aquifer system, the upper basalt-confined aquifer system, and in the lower basalt-confined aquifers for surveillance monitoring. More frequent measurements are taken at a few strategically located wells (e.g., wells 699-20-20 and 699-43-104). At regulated waste units, water levels are taken monthly, quarterly, semiannually, or annually, depending on the hydrogeologic conditions and regulatory status of a given site. This section discusses the methods to collect water-level data, describes equipment calibration/ standardization requirements, explains how monitoring wells were assigned to specific hydrogeologic units, and presents specific water-level monitoring well networks. Plate 1 shows all wells on the Hanford Site used for water-level monitoring by the groundwater project.

3.1 Data Collection Methods

Water levels are expressed as elevations above Mean Sea Level (MSL). All monitoring wells have a reference point whose elevation is obtained by geodetic survey. Field personnel determine the depth to water from this reference point. The elevation of the water level then is computed by subtracting the depth to water from the reference point elevation. In many cases, the measuring point on the well casing (i.e., the actual point on the well casing from which the depth to water measurement is made) is not the same as the reference point. When this occurs, an adjustment to the measured depth to water is made so that it reflects the depth to water from the reference point. Water-level data are collected by the groundwater project using both manual and automatic techniques. These methods are described in Sections 3.1.1 and 3.1.2.

3.1.1 Manual Measurements

Procedures developed in accordance with the techniques described in American Society for Testing and Materials (1988), Garber and Koopman (1968), NWWA/EPA (1986), and U.S. Geological Survey (1977) are followed to manually measure water levels in piezometers and wells across the Hanford Site. Manual water levels are measured primarily with laminated steel electric sounding tapes, although graduated steel tapes are available as a contingency backup. While it is Federal law and the policy of DOE to convert to metric measurement standards (DOE 1996), many of the tapes used by the groundwater project are graduated in English units and measurements are recorded in these English units. There are certain instances where activities are exempted from conversion to the metric system. Conversion of water-level monitoring by the groundwater project to the metric system will be investigated, and if circumstances do not allow for an exemption, then the metric system will be implemented in accordance with federal law and DOE policy. However, because the current measuring devices being used are graduated in English units, these units are used in the following paragraphs.

Electric sounding tapes are typically 500 feet long and mounted on a hand-cranked reel. Electrodes are contained in a weighted, stainless-steel probe at the end of the tape to (1) serve as a plumb to keep the tape taut in the well, (2) provide the user with some feel for identifying obstructions, and (3) provide insulation of the electrodes to guard against false positive indications. When the probe electrodes contact water, an electric circuit is closed and an indicator light or buzzer activates to indicate that water has been reached. The tape is held against the measuring point on the well casing at the depth that just causes the electric circuit to close. The depth to water from the measuring point is then read from the tape. The laminated steel electric tapes used by the groundwater project have a limit of precision the same as other steel measuring tapes - about 0.02 feet (0.006 meters) (American Society for Testing and Materials 1988).

Graduated steel tapes are typically 200, 300, or 500 feet long and mounted on a hand-cranked reel. The tape is usually graduated at 1 foot intervals, except for the lowermost 1 foot which is graduated at 0.01 foot intervals. To measure water levels using graduated steel tapes, a stainless-steel weight is attached to the end of the tape as a plumb. The lowermost 1 foot of the tape is chalked, usually with blue carpenter's chalk, and the tape is lowered into the well. The tape is held against the measuring point at the nearest whole foot value short of the actual depth to water, and then removed from the well. The water level is indicated by a color change in the chalk. The decimal value is then read from the lowermost 1 foot and added to the value at which the tape was held to arrive at the final depth to water from the measuring point. The limit of precision for steel tapes is about 0.02 feet (0.006 meters) (American Society for Testing and Materials 1988).

A 500 foot graduated steel tape is periodically calibrated by a standards laboratory, using standards with accuracies traceable to the National Institute of Standards and Technology (NIST). Other measuring tapes are standardized by comparison to the calibrated tape to determine their suitability for taking water-level measurements. The calibrated tape is used only to check the accuracy of other measuring tapes — it is not used for routine water-level measurements. Standardization is performed at a designated well deep enough to assess much of the length of the measuring tapes. Water-level measurements are made with the calibrated tape and with a measuring tape intended to be used for reportable water-level measurements. If the measurements agree to within 0.10 feet (0.03 meters), the measuring tape is deemed suitable for water-level monitoring.

When measuring water levels with tapes, more than one measurement is made until two measurements that agree to within 0.02 feet (0.006 meters) are obtained. After the tape is removed from the well, the wetted portion is decontaminated with deionized or distilled water to guard against cross-contamination of wells. A few wells completed in the upper basalt-confined aquifer system are under flowing artesian conditions, where the potentiometric surface is above the top of the well or piezometer. For these wells, a pressure transducer and data logger are used to measure the equivalent head above the top of the surveyed reference point.

3.1.2 Automatic Measurements

Automatic water-level monitoring is conducted to collect long-term data (i.e., days to months) at a greater frequency (e.g., hourly) than is practical with manual measurements. The purpose of higher frequency data is to evaluate the effects of external stresses on the aquifer system response. These stresses include barometric pressure changes, river-stage fluctuations, irrigation practices, and wastewater disposal activities. These data can be used to assess time-variant groundwater flow directions and hydraulic gradients that are important for understanding the migration patterns of contaminants in groundwater. Data collected near the river can also be analyzed to determine gross hydraulic properties of the aquifer between the monitoring well and the river. Automatic water-level monitoring is also conducted during hydrologic testing, including slug tests and pumping tests. The purpose of these data is to determine the hydraulic properties of the aquifer.

Automatic water-level data are collected using pressure transducers and data loggers. This equipment is installed at the well in accordance with the manufacturer's instructions. At each monitoring location, manual water levels are measured periodically with an electric sounding or steel tape (see Section 3.1.1) to verify the continuous measurements. The automated data are downloaded to a computer at the well site or via telemetry. The instruments used for automatic water-level monitoring are calibrated by the manufacturer. To verify the manufacturer's calibration, the instruments are typically user-calibrated to within ±0.01 foot before the data collection period begins.

3.2 Surveillance Monitoring

Water-level measurements are made annually in March to provide data (1) for developing a water-table map of the unconfined aquifer system for the entire Hanford Site and in adjacent offsite areas north and east of the Columbia River, (2) for a map showing annual changes to the water table, (3) for a saturated thickness map of the unconfined aquifer system, (4) for a potentiometric surface map of the upper basalt-confined aquifer system, and (5) to provide information on the vertical flow component within the unconfined aquifer system. Sections 3.2.1 through 3.2.5 describe why these measurements are made annually in March, and present the monitoring well networks used for the onsite water-table map, the potentiometric surface map, the lower basalt-confined aquifers, and for offsite areas. Wells used for monitoring hydraulic head deep in the unconfined aquifer system are included in the discussion of assigning hydrogeologic units to wells in Section 3.3. These monitoring well networks are being revised continually as wells are decommissioned and new wells are installed. The monitoring well networks presented in this section and in Sections 3.3 and 3.4 are the planned networks for fiscal year 2000.

3.2.1 Measurement Frequency and Timing

Two factors are considered to determine the frequency of surveillance water-level monitoring at Hanford: (1) the rate at which water levels change (i.e., more frequent measurements are required if water levels change rapidly), and (2) the cost associated with taking water-level measurements. The water-table map of the Hanford Site and outlying areas is intended to show groundwater flow directions and gradients at a regional scale across the site, representative of the year in which the measurements are taken. However, water levels are subject to seasonal variations, especially in wells adjacent to the Columbia River. Although contaminant plumes respond locally to seasonal variations, their long-term movement is determined by the average (or net) flow rate and direction. Thus, one way of documenting the average flow condition is to measure water levels several times a year and average the results. While effective, however, such an approach is costly.

A better, more cost-effective method, is to measure water levels once a year at a time when the groundwater flow system is closest to its annual average condition. The Columbia River represents the largest, short-term external stress on water levels in the unconfined aquifer system. The average and the range of monthly discharge in the Columbia River along the Hanford Site as well as the average annual discharge for 30 years of record is shown in Figure 3.1. This data, as well as the standard deviation, is also given in Table 3.1. In addition to this criterion, it is desired that the month chosen coincide with the months in which water-level measurements are taken at the regulatory units (December, March, June, and September).

The month chosen for annual water-level measurements should have a mean monthly river discharge close to the annual average discharge (3,340 cubic meters per second) and the standard deviation or range of the mean monthly discharge is small. No month fully meets this criteria, so the month chosen for the annual measurements is a compromise. March represents the best compromise – it is the only month having a mean monthly river discharge (3,300 cubic meters per second) near the annual average discharge and also coincides with the regulated-unit measurements. The standard deviation (985) is higher than desired, but much lower than the standard deviation for some other months (e.g., 2,380 for June or 1,560 for July). Another advantage to March is that the mean river discharge for the previous 3 months is near the annual average. This allows water-levels in the adjacent aquifer a chance to recover from the high and low flow conditions occurring in the summer and fall. A disadvantage to March is that river flow can be affected in some years by an early spring runoff. However, when this occurred during the last 30 years of record (fiscal year 1967 through fiscal year 1996), only in 5 years did the peak discharge during a fiscal year occur in March or earlier. Therefore, March was chosen for taking annual surveillance water-level measurements on the Hanford Site.

As was stated previously, water-level measurements are used to determine groundwater flow directions and velocities. Water-level changes resulting from fluctuations of Columbia River stage or barometric pressure can be greater than the water-table gradient. To best minimize the effect of these fluctuations, wells in proximity to each other should be measured closely in time. When the annual surveillance measurements are taken, wells north of Gable Butte and Gable Mountain are measured first, followed by wells in the 200 Areas, and the remaining wells on site are measured generally from the northwest to the southeast.

3.2.2 Hanford Site Water-Table Monitoring Network

A relative monitoring-zone classification system is used to determine the suitability of a given well for water-table monitoring. For the unconfined aquifer system, this classification system categorizes wells based on the position of their open interval in relation to the water table and the Ringold Formation mud units. Table 3.2 describes each relative zone category. Although the degree to which the water level in a well is representative of the water-table elevation in an aquifer is a subject of ongoing study (see Section 4.1 for a more complete discussion), it is assumed that wells completed at the top of the unconfined aquifer system (zone TU) yield water levels that approximate the water-table elevation accurately enough to determine regional groundwater flow rates and directions. There are three locations on the Hanford Site where a TU well occurs adjacent to a well completed in the upper part of the unconfined aquifer system (zone UU), excluding those wells having non-RCRA compliant nested piezometer completions (i.e., piezometers that may not be hydraulically isolated). Water levels in these wells for June 1998 are given in Table 3.3. As shown, the water-level elevation in each cluster differs by only 1 or 2 centimeters. Therefore, it is assumed that water levels in UU wells also provide a good approximation of the water-table elevation.

Many of the wells outside of the operational areas monitor large open vertical intervals within the aquifer, and, therefore, are designated as undifferentiated unconfined (U). Such wells provide an average (or composite) head across the screened interval. These wells are evaluated individually to determine if they are suitable for water-table monitoring. It is assumed that if a mud unit is not present within the screened interval, then the composite head approximates the water-table elevation, generally to within 30 centimeters. Figure 3.2 presents a histogram of water-level elevation differences between TU or UU wells and adjacent wells completed deep in the unconfined aquifer system but not subject to local confining conditions by the Ringold Formation mud units (zone DU). All comparisons are for measurements taken on the same day during June 1998. Again, non-RCRA compliant nested piezometer completions are excluded. For 75% of the comparisons, the water-level elevation in the DU well differs from the nearby TU or UU well by less than 15 centimeters, and the difference was less than 30 centimeters for 95% of the comparisons. The same comparison was made between TU and UU wells with those unconfined aquifer system wells that are locally confined by the Ringold Formation mud units (zone CR) and those completed at the top of basalt (zone TB) where mud units are present, again excluding non-RCRA compliant nested piezometer completions. A histogram of these results is shown in Figure 3.3. Although the number of comparisons is small, the water-level difference between TU or UU wells and adjacent CR or TB wells suggests an approximate uniform distribution up to about 16 meters difference. It is clear that wells screened below the Ringold mud units are not suitable for water-table monitoring. Therefore, U wells open within or below the Ringold Formation mud units are deemed unsuitable for water-table monitoring and are not part of the water-table monitoring network. However, those U wells completed above the mud units, or occurring where the mud units are absent, should provide an approximation of the water-table elevation, with an error generally less than about 30 centimeters. These wells are used where TU or UU wells are not available.

Plate 2 shows the wells used for water-table monitoring along with their relative monitoring-zone classification. Adequate well coverage occurs over much of the Hanford Site. However, poor well coverage exists south and west of the 200-West Area, south of the 100-F Area, and east of B Pond and the Treated Effluent Disposal Facility (TEDF). This poor coverage is due entirely to a lack of suitable wells available for water-table monitoring. In addition, heavy use is made of U wells west of the 200-West Area and east of the B Pond/TEDF region. These deficiencies are regional in scale and apply to regions outside of the operational areas, so these deficiencies do not in any way reflect on the adequacy of the local-scale well networks used for monitoring at specific regulated waste units.

3.2.3 Offsite Water-Level Monitoring Network

Spane and Webber (1995) assessed the potential for contaminants in the upper basalt-confined aquifer system to migrate offsite east of the Columbia River.[1] They concluded that this potential was low, because (1) the Columbia River forms a dominant line-sink discharge area for the upper basalt-confined aquifer system in this region (see Figure 2.3), and (2) high hydraulic head conditions east of the Columbia River further preclude the offsite migration of contaminants (see Figure 2.2). If the hydraulic heads in this region were to begin falling, a situation might develop that would be more favorable for the offsite migration of contaminants. Minimal water-level monitoring east of the Columbia River is routinely performed by the groundwater project to provide an alert should this situation develop.

The areas east of the Columbia River most susceptible to offsite contaminant migration are those regions where hydraulic heads are lowest. Hydraulic heads are lowest in the Ringold and Esquatzel Coulees (see Figure 2.2). Therefore, a selected set of water-level measurements are taken annually by PNNL from wells within these coulees, to assess long-term trends in hydraulic heads. Figure 3.4 presents the water-level monitoring network for the offsite areas. The wells measured are mostly U.S. Bureau of Reclamation wells completed within the uppermost unconfined aquifer. Because this region is dominantly a recharge area, hydraulic heads in deeper aquifers are lower and would be preferred for long-term water-level monitoring to assess offsite contaminant migration. However, wells completed in the deeper aquifers serve as water supply wells, and are thus not suitable for water-level monitoring. There is one nested piezometer completion (outside of the coulees) that does provide information for deeper aquifers (14/27-3P), and this cluster also is measured annually. Every five years, water levels are taken in a much larger set of wells east and north of the Columbia River to update the water-table contours in these offsite areas. This was most recently performed in 1995.

[1] For this report, "offsite" refers to those areas north and east of the Columbia River, even though part of this region is still within the Hanford Site boundary. Similarly, "onsite" refers to those wells south and west of the Columbia River, including wells in the Richland area that are outside of the Hanford Site boundary.

3.2.4 Upper Basalt-Confined Aquifer System Water-Level Monitoring Network

Water-level measurements are taken annually in wells completed within the upper basalt-confined aquifer system and are used to construct a potentiometric surface map (Figure 2.3). Figure 3.5 presents the well network for this aquifer system. Most of the monitoring wells are completed in the Rattlesnake Ridge Interbed and are located between the 200-East Area and Gable Mountain. Well coverage is limited for both the northern and southern parts of the site, resulting in an uncertain potentiometric surface in these areas.

3.2.5 Lower Basalt-Confined Aquifers Water-Level Monitoring Network

Water-level measurements are also taken annually in wells completed within the lower basalt-confined aquifers beneath the upper basalt-confined aquifer system. Figure 3.6 presents the well network for these measurements. These data are collected so that if contamination is found in the lower aquifers, an archive of water-level measurements would be available for use in assessing historical groundwater flow and for possible identification of the contamination source. In addition, water-levels in the lower basalt-confined aquifers provide information to assess the effect of stresses external to the Hanford Site on the groundwater system. For example, many irrigation water supply wells in adjacent offsite areas are completed in the lower basalt-confined aquifers, and their operation could influence the flow system beneath the Hanford Site.

3.3 Assignment of Monitoring Wells to Hydrogeologic Units

Water-table maps provide a hydraulic head distribution that allows for groundwater flow rate and direction determinations only within the uppermost part of the unconfined aquifer system. To understand how water moves through an aquifer, it is necessary to obtain information on the vertical distribution of hydraulic head. The unconfined aquifer system is subdivided into nine hydrogeologic units, as described in Section 2.3.1. By measuring hydraulic head within each unit, it is possible to (1) determine the horizontal component of groundwater flow within that unit, and (2) determine the vertical gradient between units, and thus evaluate the vertical component of groundwater flow. These measurements are also needed to support groundwater model calibration. To document hydraulic heads within each hydrogeologic unit, the groundwater monitoring wells completed within each unit need to be identified. This section discusses how this is accomplished and presents the monitoring well network for each unit.

3.3.1 Approach and Limitations

To determine which hydrogeologic unit(s) is monitored by a particular well, three criteria were evaluated: (1) the effective screened interval of the well, (2) the elevation for the top and bottom of each hydrogeologic unit present at the well location, and (3) the water-table elevation at the well location. The effective screened interval is that portion of a well that is open (i.e., perforated or screened) to the surrounding sediments. The effective screened interval is obtained by examining the available documentation for the well, such as well completion diagrams or driller's logs. The configuration of some Hanford Site groundwater monitoring wells have been modified over the years, sometimes without adequate documentation. In these cases, the original screened or perforated interval is used until field checks can be performed.

Information on the hydrogeologic units present at each well is obtained from several sources. Wurstner et al. (1995) presents a conceptual model for the Hanford Site unconfined aquifer system based on an analysis of the hydrogeologic units identified in about 570 wells drilled to basalt. Their results are primarily in the form of a database of the hydrogeologic unit elevations in the wells analyzed, and a three-dimensional model of the Hanford Site hydrogeology developed using the EarthVision® software package (version 3.0, Dynamic Graphics Inc. 1995). Recent unpublished work in the vicinity of the 200-East Area and B Pond resulted in additional interpretations of the hydrogeologic units present at wells in this area using additional information sources than were used by Wurstner et al. (1995) (e.g., geophysical logs and an analysis of archived sediment samples). Additional interpretations are made specifically for this monitoring plan. If sediments for a well were not previously subdivided into hydrogeologic units, the EarthVision® model is used to extrapolate the units present at each well location. The quality of the hydrogeologic interpretation at each well is dependent on the method used to identify the units and the information available. A recent interpretation is considered the highest quality, followed by interpretations for Wurstner et al. (1995), with extrapolation from the conceptual model considered the least accurate.

Once this information is available, the elevation of the water table is compared to the elevation of the screened interval and the elevation of the hydrogeologic units to determine which units are actually present over the saturated screened interval. These results are presented in the next section as well as in Table A.1 of Appendix A.

This represents the first attempt to assign hydrogeologic units to the Hanford Site water-level monitoring wells used by the groundwater project. Most of the hydrogeologic unit assignments were made using the EarthVision® conceptual model. Uncertainty in these assignments can be assessed by comparing the EarthVision® conceptual model with the recent interpretations. Because these recent interpretations were made mostly in the vicinity of the 200-East Area and B Pond, the results of this assessment are skewed toward this region. The elevations of the hydrogeologic unit contacts in the EarthVision® conceptual model (which are based on the interpretations of Wurstner et al. [1995]) and the recent interpretations were compared for wells where a recent interpretation is available and the two methods agree that a particular hydrogeologic unit is present. This comparision is not limited to only those units in the saturated open interval, but considers all units present from the surface to the bottom of each borehole (note: all nine hydrogeologic units are not necessarily present at each well location). The comparison was performed for 101 wells, and the mean elevation difference (lumped for all hydrogeologic units) was found to be 5.3 meters with a median of 1.6 meters and a standard deviation of 7.6. Table 3.4 gives the results of this comparison for each hydrogeologic unit separately.

It should be pointed out that many of the recent interpretations result from a detailed study of the local region in the vicinity of the 200-East Area and B Pond, whereas the EarthVision® conceptual model represents a regional-scale interpretation of the Hanford Site hydrostratigraphy. Because of this difference in scale, there are bound to be differences in the interpreted hydrostratigraphy. However, these results do demonstrate a need to continually reassess the conceptual model as new information (including different interpretations of existing data) become available. Therefore, because the conceptual model is likely to be continually revised over time, the assignment of hydrogeologic units to the water-level monitoring wells presented here will also be continually revised with time.

3.3.2 Hydrogeologic Unit Well Networks for the Unconfined Aquifer System

Figures 3.7 through 3.15 present the water-level monitoring networks for all hydrogeologic units as well as the top of the uppermost basalt flow, except for Unit 2, along with the extent of each unit below the water table determined from the EarthVision® conceptual model. As stated in Section 2.3.1, Unit 2 is entirely above the water-table. For clarity in the figure, well names are omitted — the hydrogeologic unit(s) present at each well are tabulated in Appendix A.

These figures also show the source of the hydrogeologic interpretation (i.e., recent interpretation, interpretation for Wurstner et al. (1995), or conceptual model extrapolation) for each well, along with whether or not each well is completed solely within a given unit. Wells completed only within a single unit provide a hydraulic head representative of that unit and will be most useful for model calibration, whereas wells completed across multiple units provide a composite head that may not be as useful. Some wells assigned to a given unit are depicted outside the extent of that unit. For many of these instances, the hydrogeologic units assigned to the wells result from a recent interpretation.

3.4 Regulated Unit-Water Level Monitoring

There are 31 regulated units on the Hanford Site for which water-level monitoring is performed by the groundwater project. The location of these units is shown in Figure 3.16. The frequency at which water-level measurements are collected at each site ranges from monthly to annually. Quarterly measurements are taken in December, March, June, and September. Semi-annual measurements are taken in March and September, except for those taken at A-AX and C Tank Farms, where they are taken in December and June. Finally, annual measurements are taken in March. The water-level monitoring network for each site is presented in Figures 3.17 through 3.38. These figures not only show the wells used for water-level measurements, but also denote the relative monitoring zone assigned to each well (see Table 3.2 for a description of the relative monitoring zones). To determine the hydrogeologic unit(s) monitored by a given well, refer to Appendix A.

Table 3.1. Monthly Mean, Standard Deviation, and Range of Discharge (Q) in the Columbia River Along the Hanford Site for Fiscal Years 1967 Through 1996

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean Monthly Q (m^3/s)	2,300	2,580	2,960	3,190	3,260	3,300	3,360	4,430	5,200	4,090	3,070	2,310
Monthly Q Standard Dev.	282	384	563	689	759	985	1,000	1,180	2,380	1,560	801	390
Minimum Monthly Q (m^3/s)	1,880	1,850	2,090	1,990	2,110	1,730	1,640	2,240	2,230	2,030	1,890	1,700
Maximum Monthly Q (m^3/s)	2,990	3,430	4,640	4,770	5,520	5,710	5,360	7,640	12,250	8,160	5,410	3,590
Annual Columbia River Discharge: Mean = 3,340 m^3/s, Standard Deviation = 584.												

Table 3.2. Relative Monitoring-Zone Classification Scheme

Zone	Description
U	(Undifferentiated Unconfined) Open to more than 15 m of the unconfined aquifer system, or the open/monitoring interval depth is not documented but is known to be within the unconfined aquifer system.
TU	(Top Unconfined) Screened across the water table with the bottom of the open interval at no more than 10 m below the water table.
UU	(Upper Unconfined) Screened across the water table and the bottom of the open interval is more than 10 m but not more than 15 m below the water table, or screened below the water table and the bottom of the open interval extends no more than 15 m below the water table.
DU	(Deep Unconfined) Screened below the water table and (1) the bottom of the open interval is more than 15 m below the water table, (2) the bottom of the open interval is not more than 3 m below the top of basalt, (3) the well is not open to more than 15 m of the aquifer, and (4) the well is not subject to local confining conditions.
CR	(Confined Ringold) Wells in the unconfined aquifer system which are subject to local confining conditions by the mud units of the Ringold Formation and the bottom of the open interval is not more than 3 m below the top of basalt.
TB	(Top Basalt) Bottom of the open interval is more than 3 m but not more than 10 m below the top of basalt.
C	(Undifferentiated Basalt-Confined) Open interval extends across the dense interior of the Pomona Member of the Saddle Mountains Basalt, or open/monitoring interval depth is not documented but is known to be within the basalt confined aquifers.
UC	(Upper Basalt-Confined) Open to the upper basalt-confined aquifer system (i.e., does not extend below the dense interior of the Pomona Member of the Saddle Mountains Basalt).
LC	(Lower Basalt-Confined) Open to the basalt and interflow zones below the dense interior of the Pomona Member of the Saddle Mountains Basalt.

Table 3.3. Comparison of Water-Level Elevations in Top of Unconfined (Zone TU) and Upper Unconfined (Zone UU) Wells in the Same Cluster

Well Name	Location	Zone[1]	Distance Between Wells, m	Date	Water-Level Elevation, m	Elevation Difference, m
199-N-72	100-N Area	TU		6/1/1998	119.76	
199-N-77	100-N Area	UU	10.1	6/1/1998	119.78	+0.02
699-S31-E10B	Richland North	TU		6/29/1998	108.04	
699-S31-E10C	Richland North	UU	9.2	6/29/1998	108.02	-0.02
699-S38-E12A	Richland North	TU		6/29/1998	107.98	
699-S38-E12B	Richland North	UU	7.0	6/29/1998	107.97	-0.01

[1] See Table 3.2 for a detailed description of the relative monitoring zone classification codes.

Table 3.4. Statistical Summary of the Difference (Absolute Value) in the Top of Hydrogeologic Unit Elevations Between the Recent Hydrogeologic Unit Interpretations and Conceptual Model Extrapolations

Hydrogeologic Unit	Mean, m	Median, m	Minimum, m	Maximum, m	Standard Deviation	Number of Measurements
1	7.0	2.3	0.0	44.1	9.4	101
2	3.9	4.2	0.7	6.4	2.6	4
3	1.0	0.7	0.2	2.4	0.8	5
4	4.1	5.4	1.0	5.9	2.7	3
5	8.0	1.2	0.0	30.0	10.8	19
6	1.6	0.5	0.1	6.0	2.5	5
7	4.5	3.4	0.3	9.9	4.6	6
8	10.0	10.2	0.4	33.4	8.8	18
9	7.2	4.5	0.3	20.5	6.7	24
Basalt	1.6	1.0	0.0	13.6	2.1	66

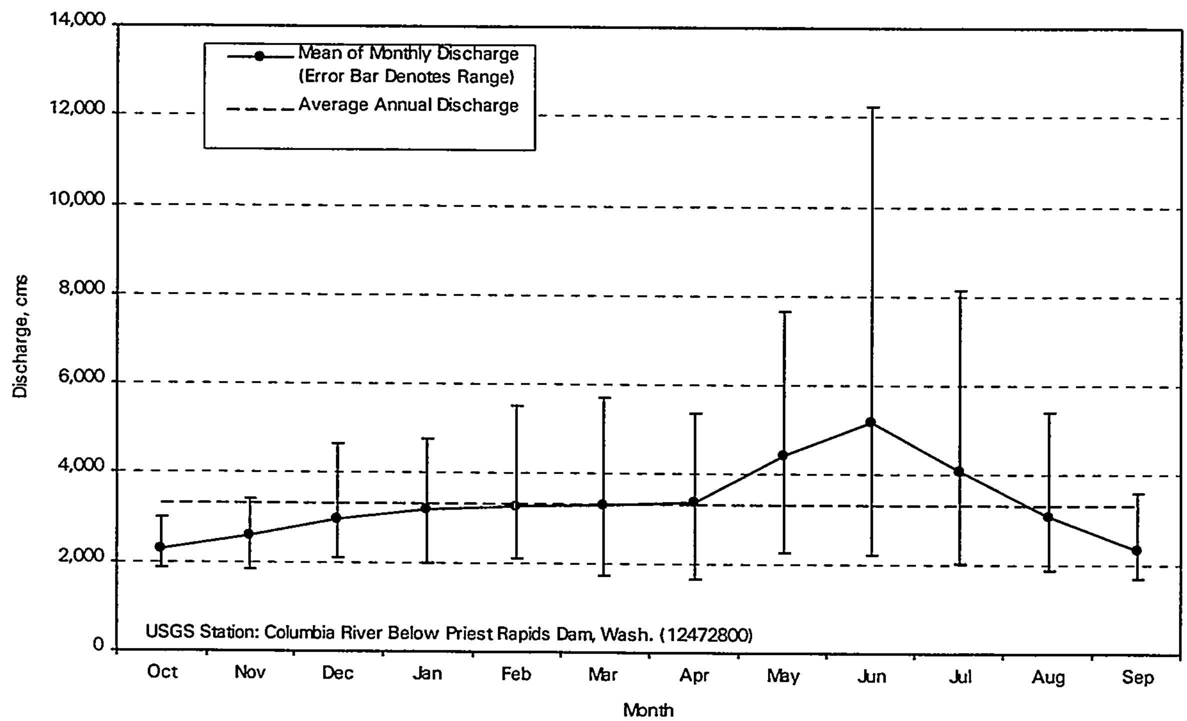

Figure 3.1. Mean and Range of Monthly Discharge Compared to Average Annual Discharge in the Columbia River Along the Hanford Site for Fiscal Years 1967 Through 1996

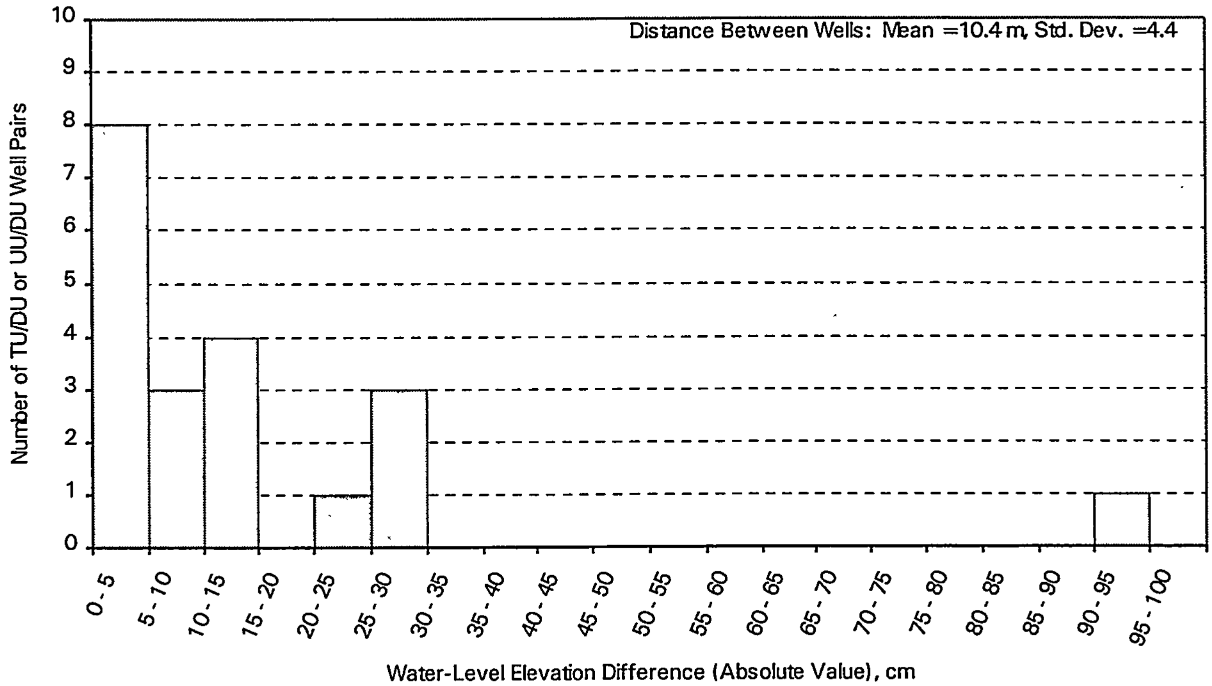

Figure 3.2. Histogram of June 1998 Water-Level Elevation Differences Between Top or Upper Unconfined Wells (Zone TU or UU) in the Same Cluster with Wells Completed Deep in the Unconfined Aquifer System but not Subject to Local Confining Conditions (Zone DU)

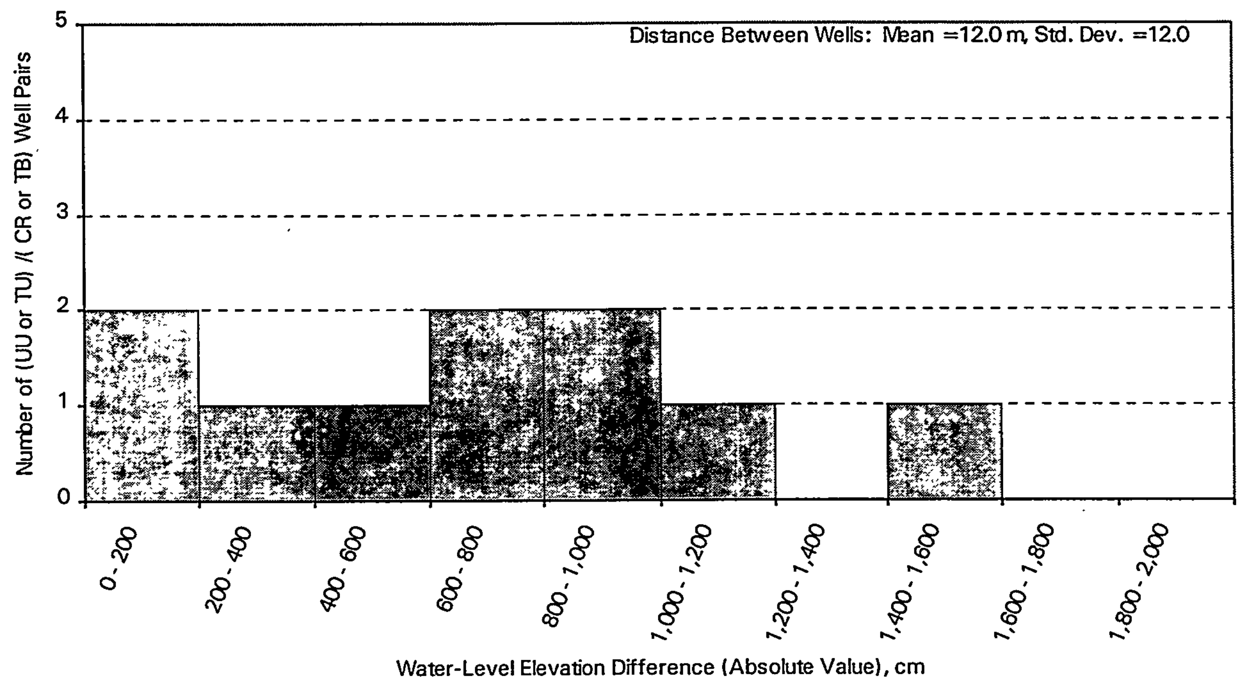

Figure 3.3. Histogram of June 1998 Water-Level Elevation Differences Between Top or Upper Unconfined Wells (Zone TU or UU) in the Same Cluster with Confined Ringold or Top of Basalt Wells (Zone CR or TB)

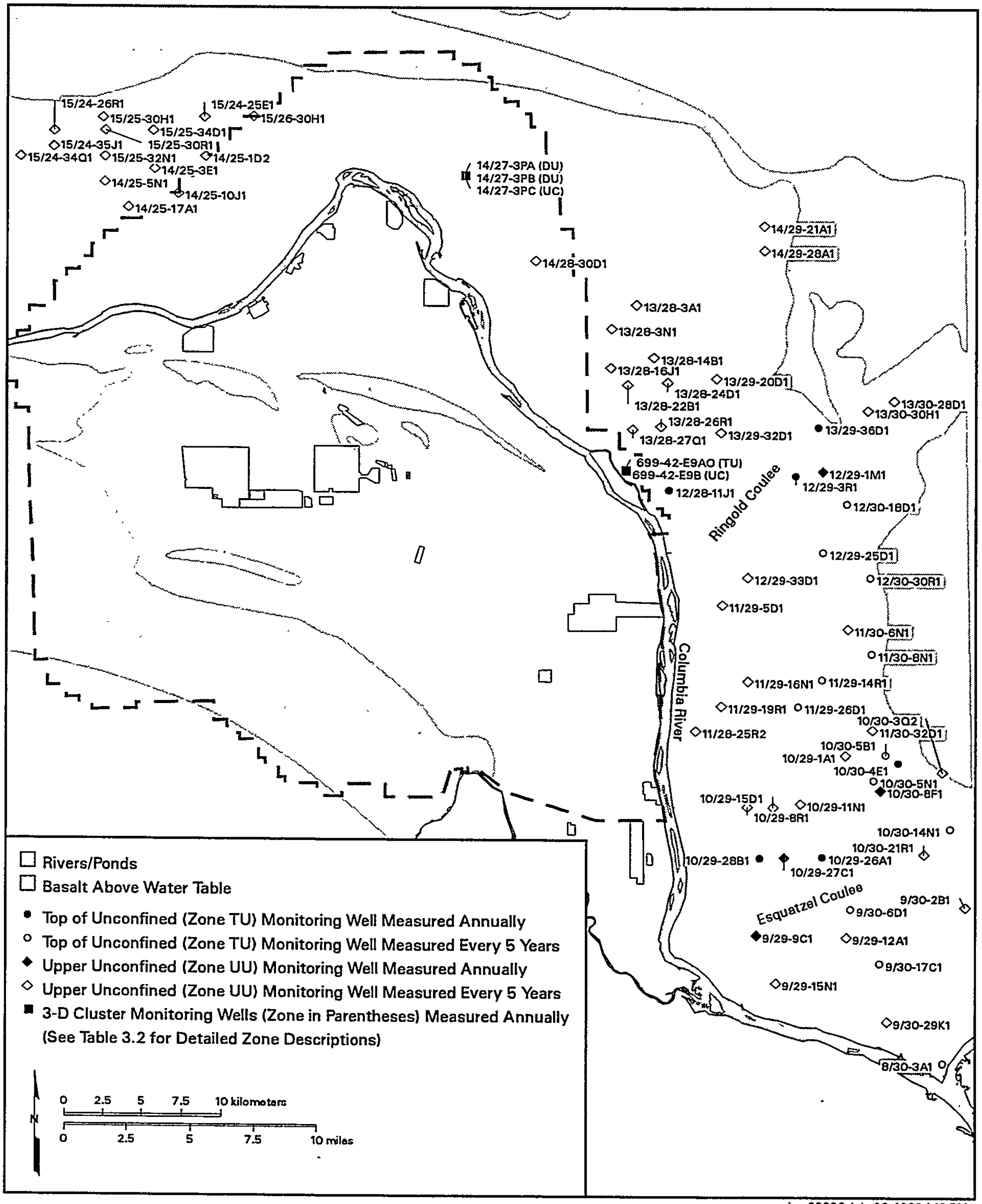

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Figure 3.4. Water-Level Monitoring Network for the Offsite Areas North and East of the Columbia River

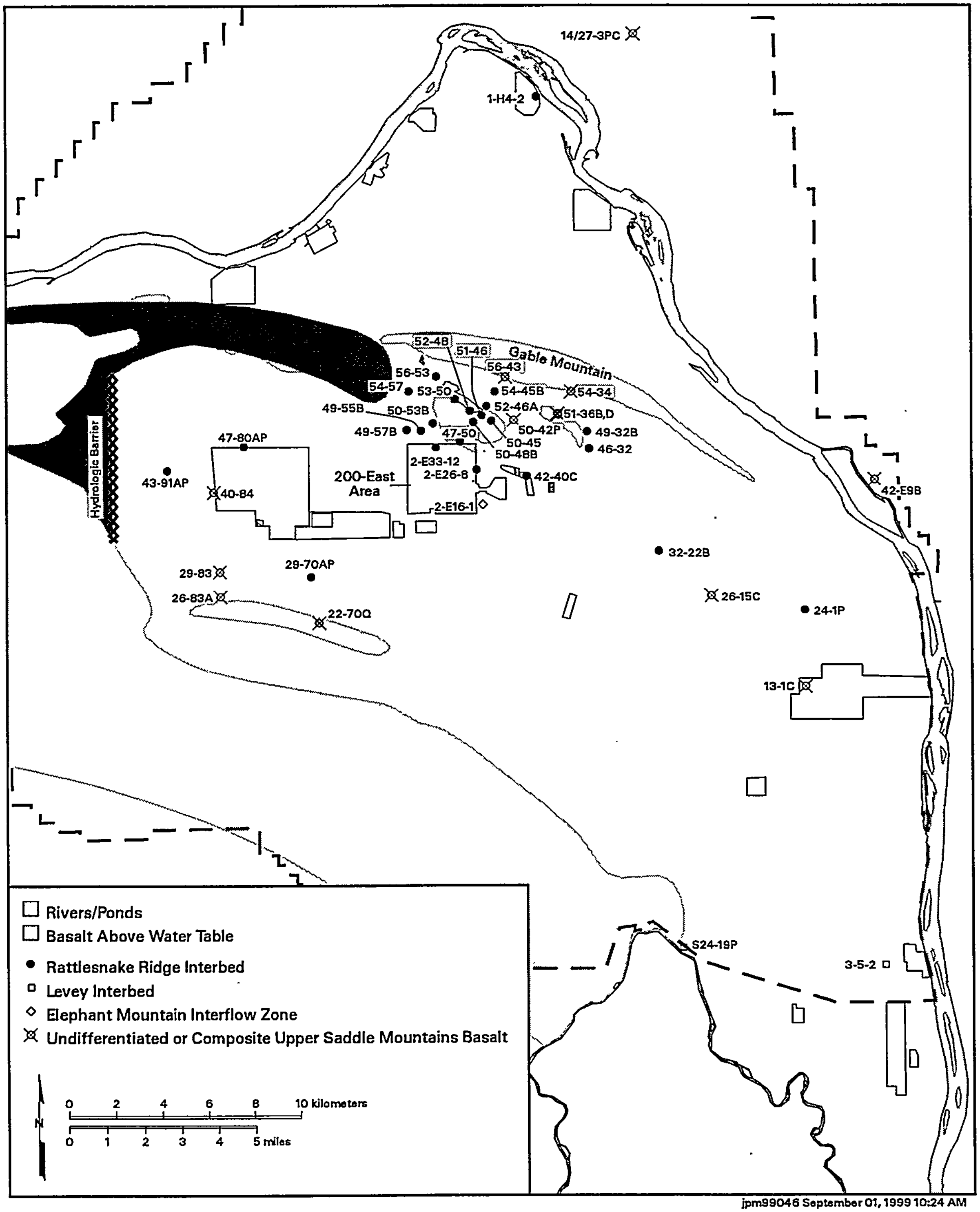

Figure 3.5. Water-Level Monitoring Network for the Upper Basalt-Confined Aquifer System

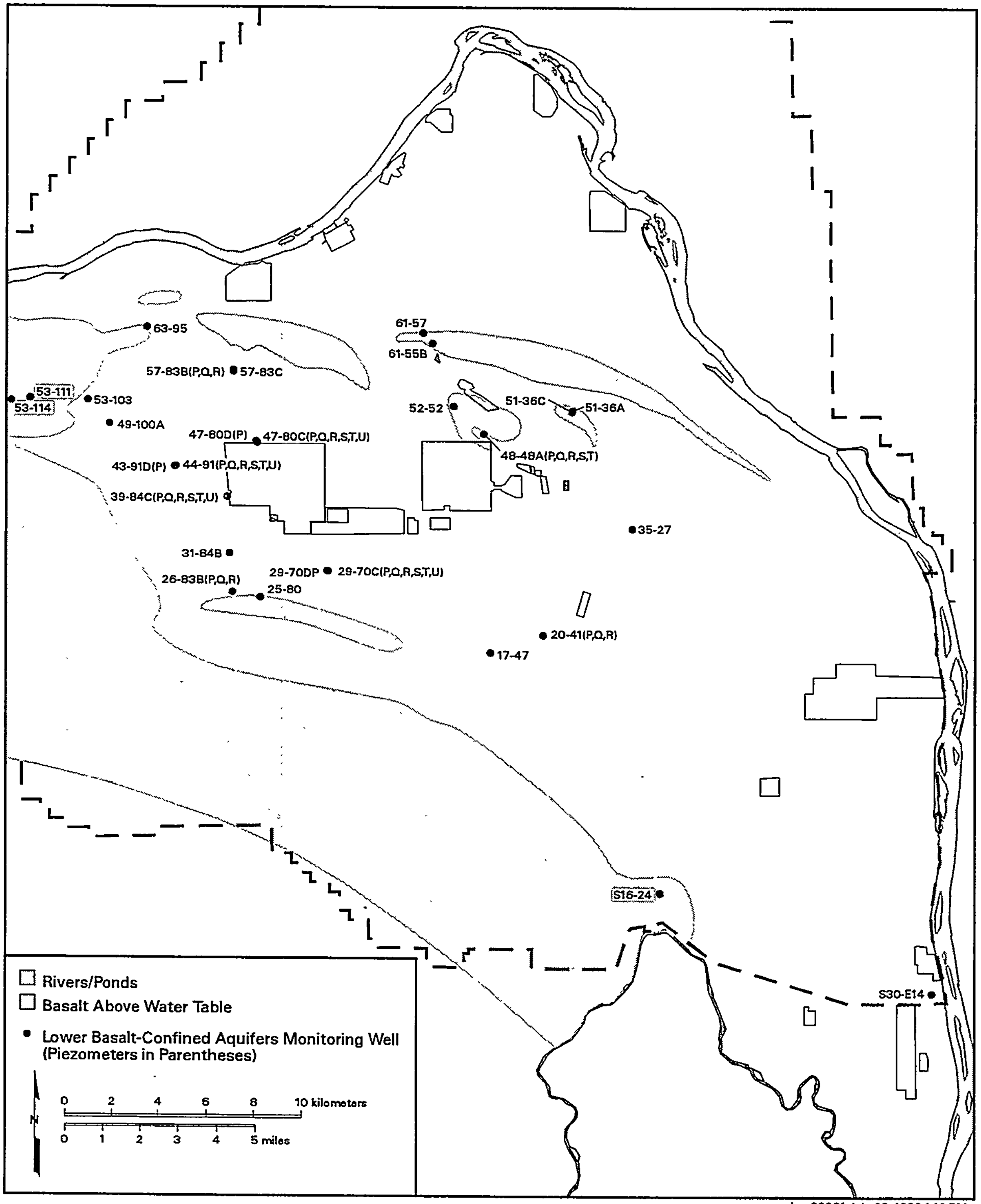

Figure 3.6. Water-Level Monitoring Network for the Lower Basalt-Confined Aquifers

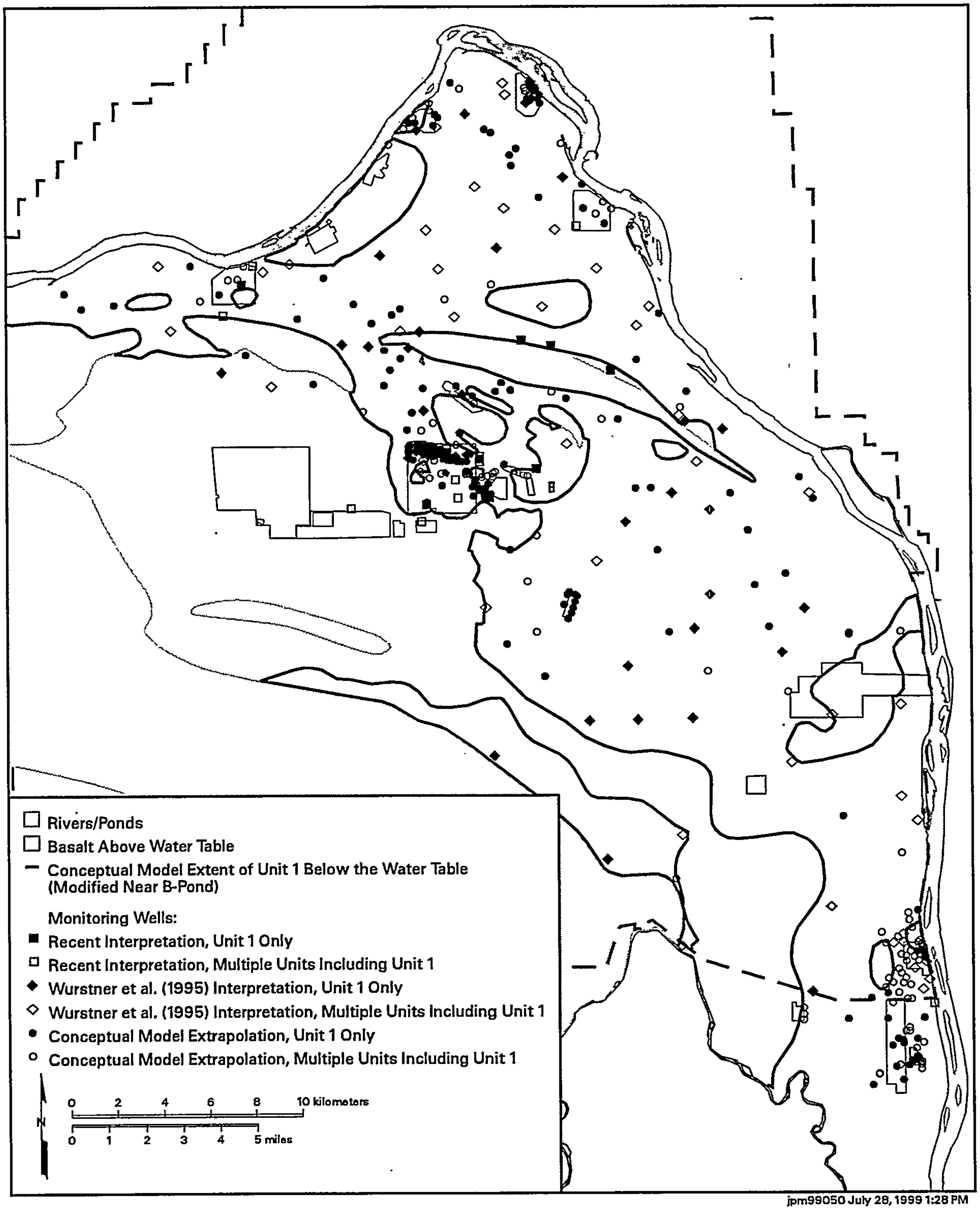

Figure 3.7. Water-Level Monitoring Network for Hydrogeologic Unit 1

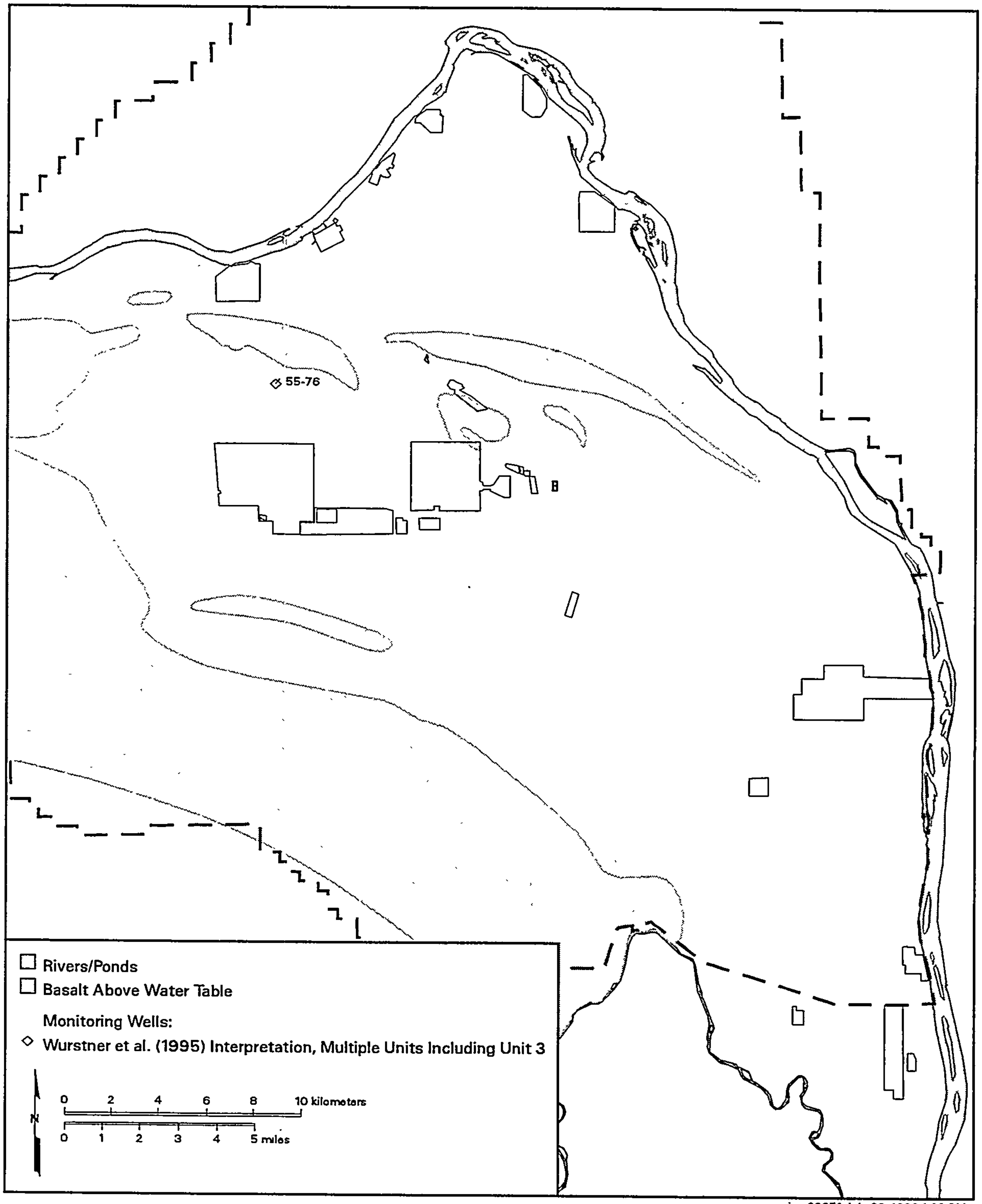

Figure 3.8. Water-Level Monitoring Network for Hydrogeologic Unit 3

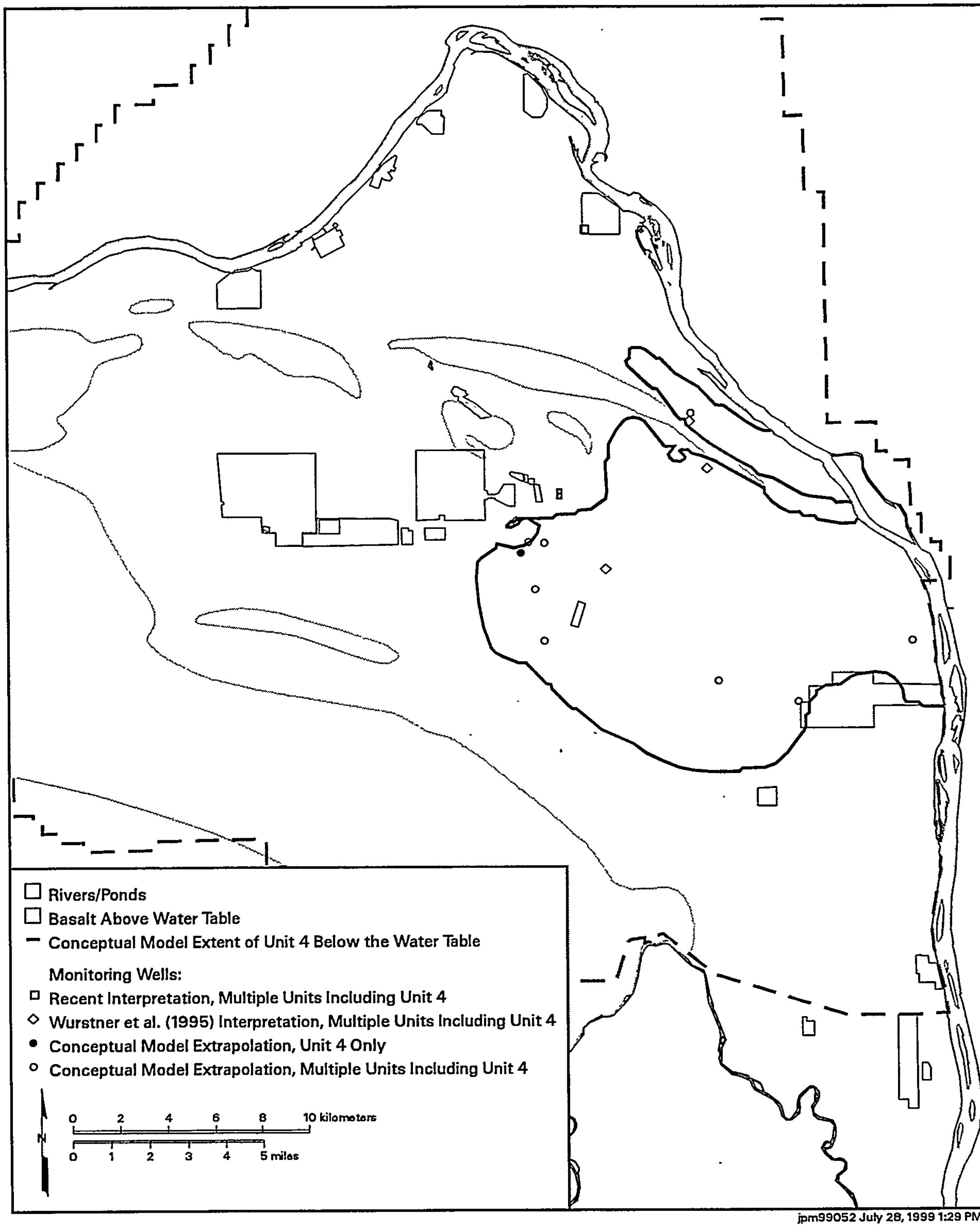

Figure 3.9. Water-Level Monitoring Network for Hydrogeologic Unit 4

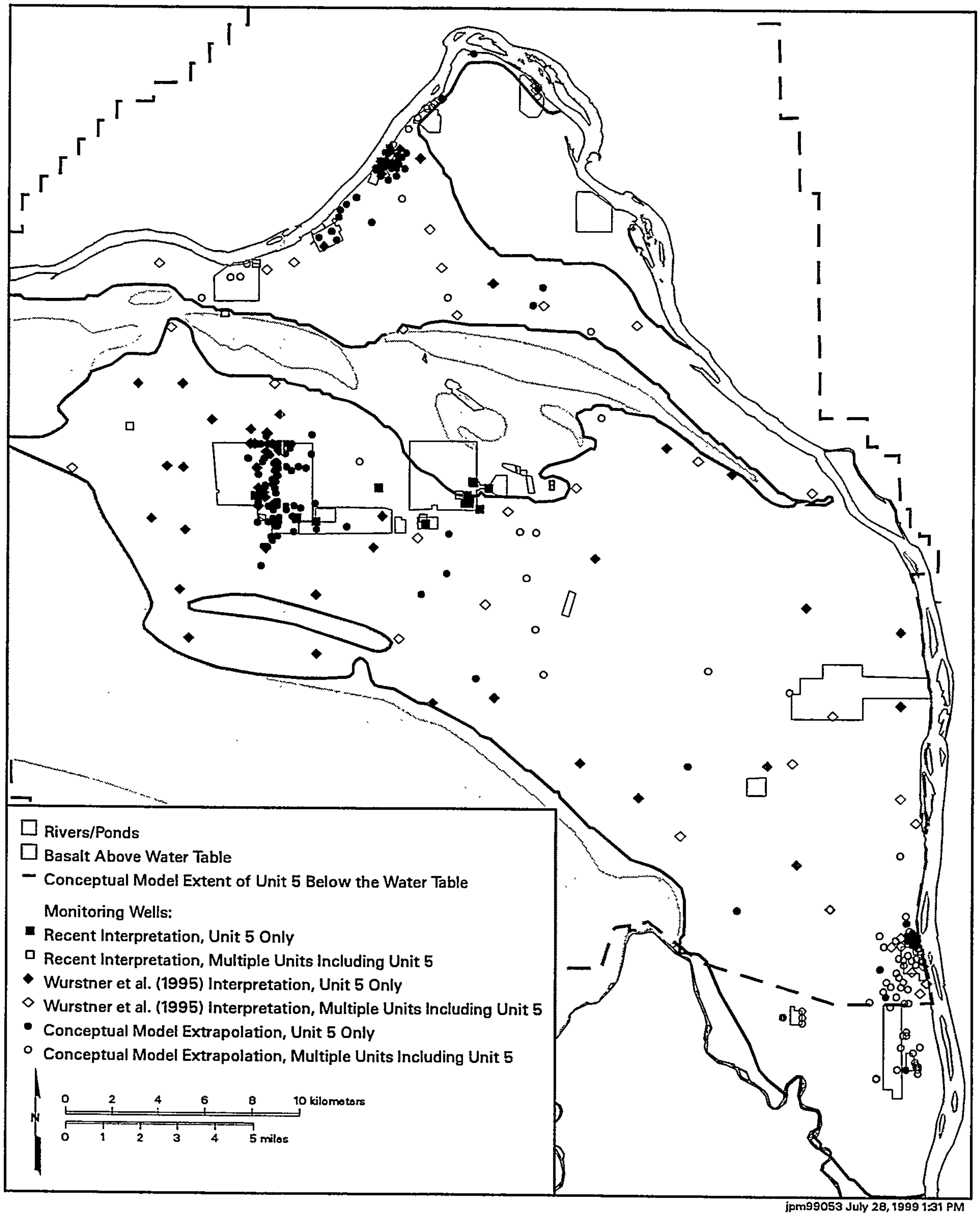

Figure 3.10. Water-Level Monitoring Network for Hydrogeologic Unit 5

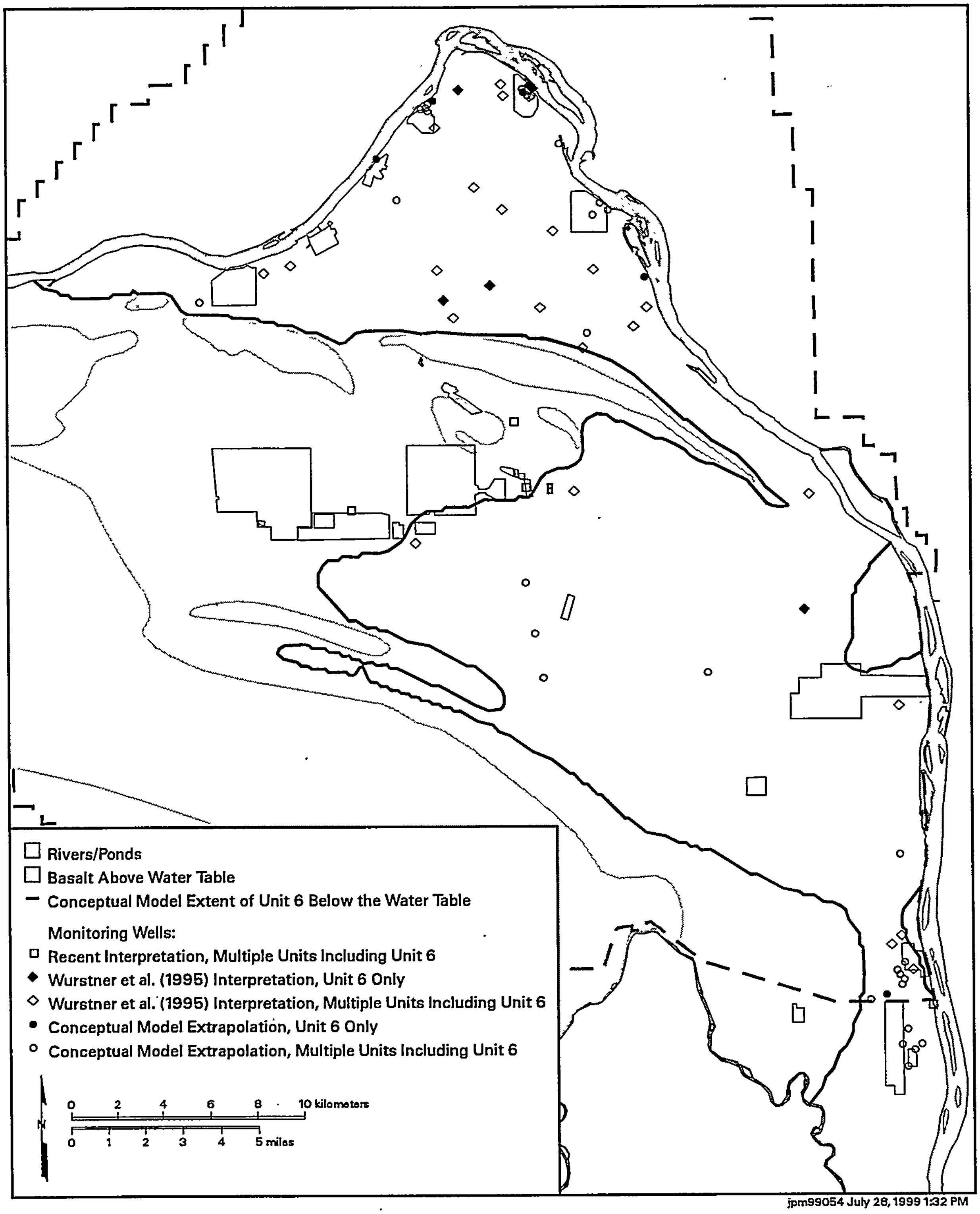

Figure 3.11. Water-Level Monitoring Network for Hydrogeologic Unit 6

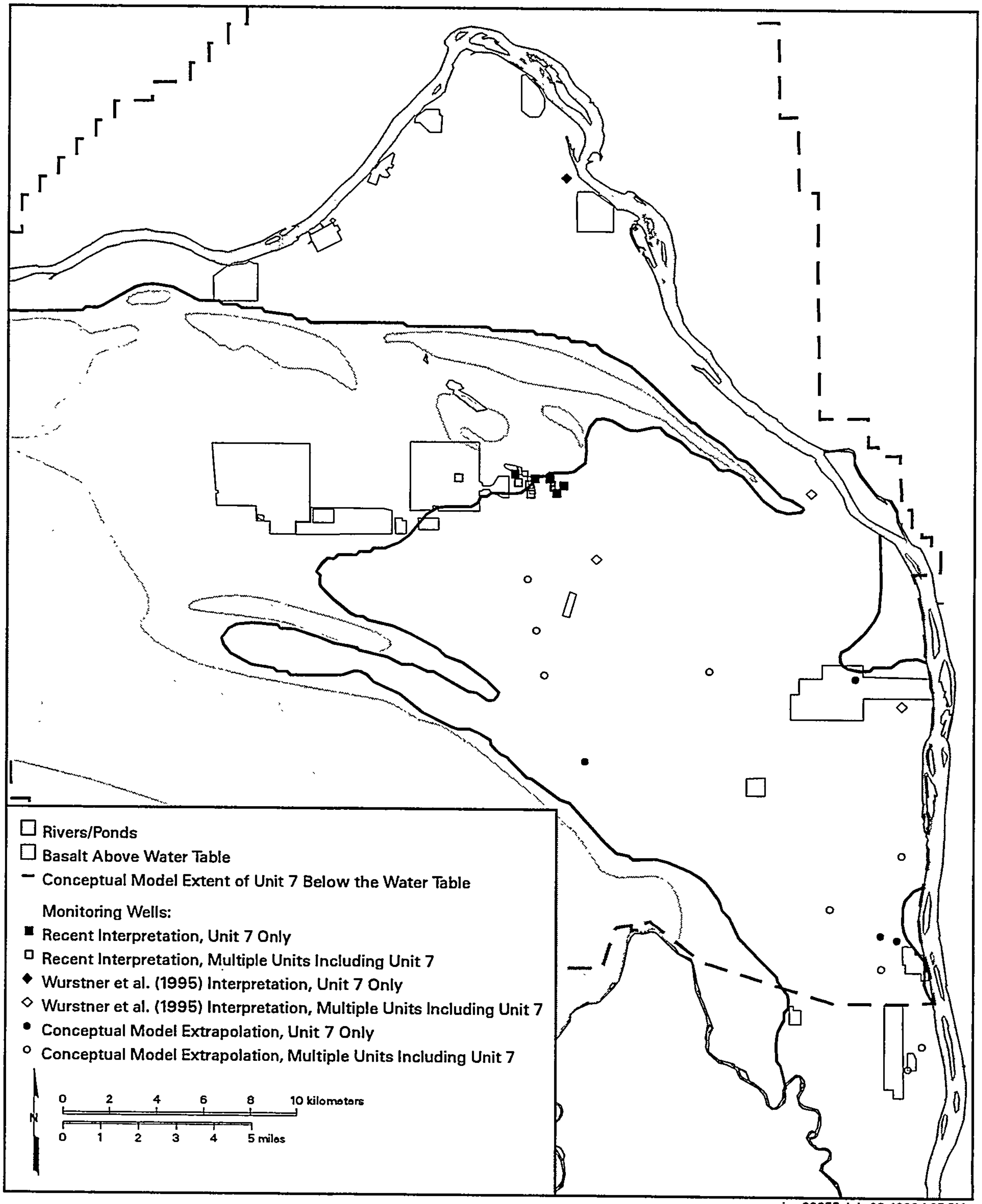

Figure 3.12. Water-Level Monitoring Network for Hydrogeologic Unit 7

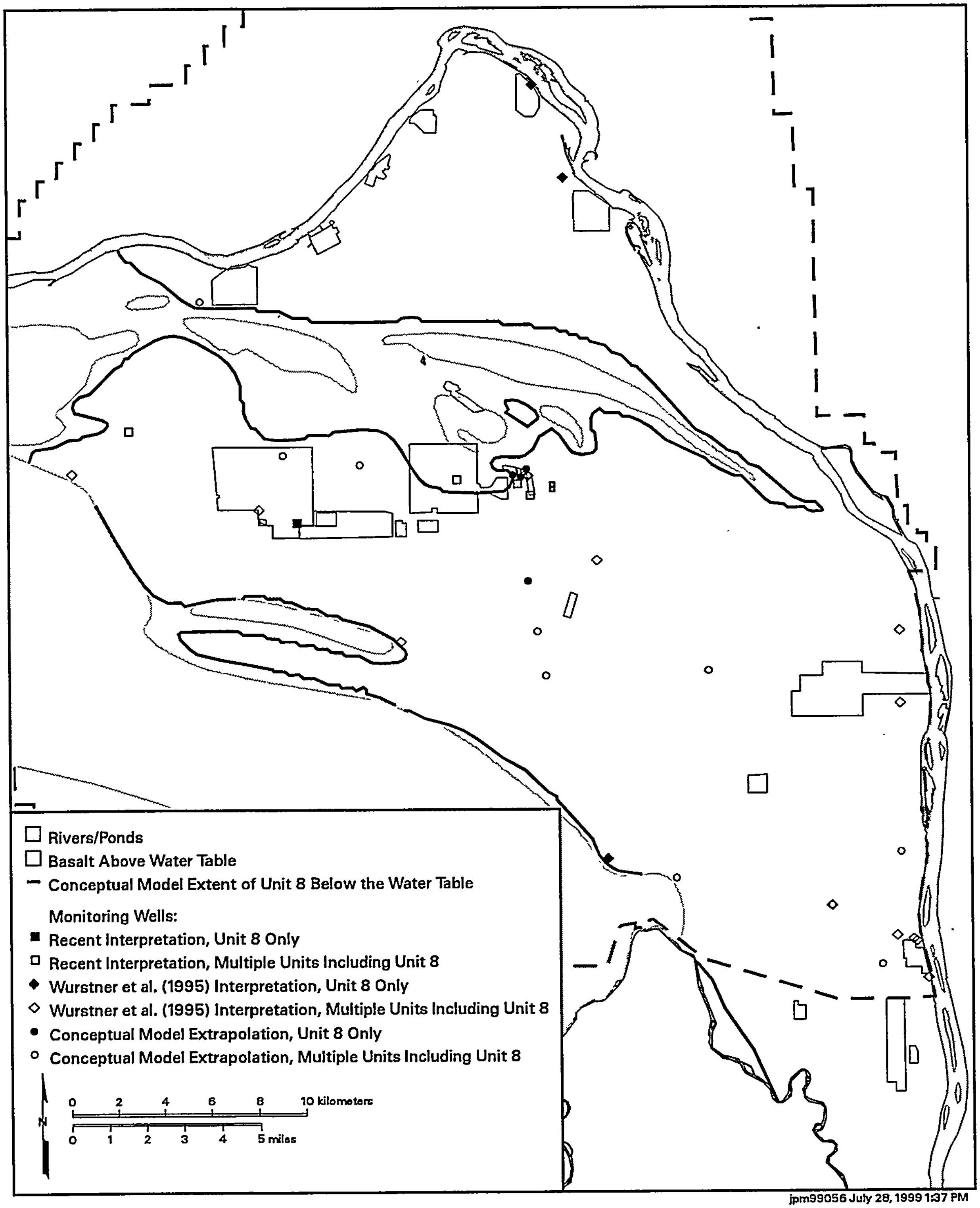

Figure 3.13. Water-Level Monitoring Network for Hydrogeologic Unit 8

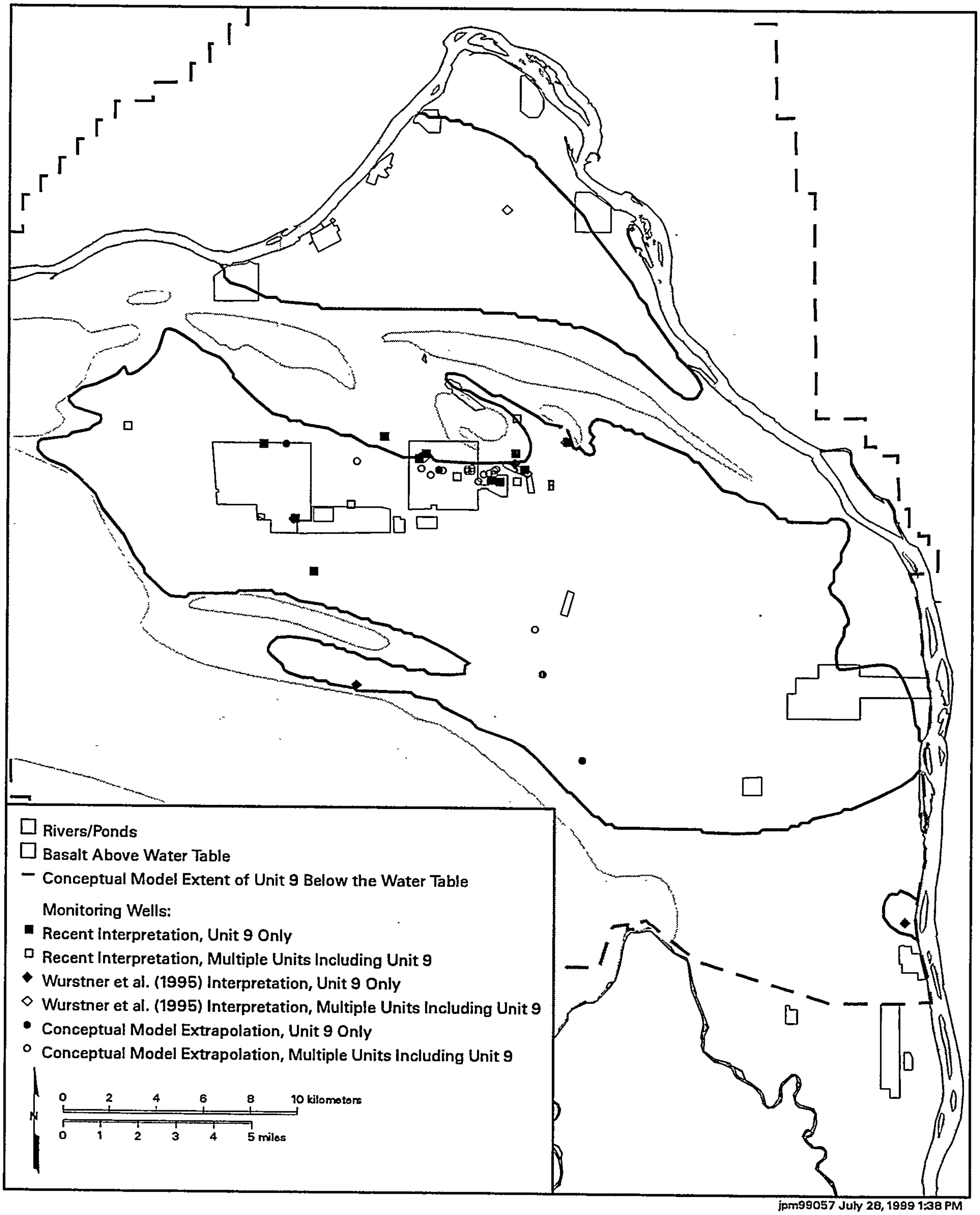

Figure 3.14. Water-Level Monitoring Network for Hydrogeologic Unit 9

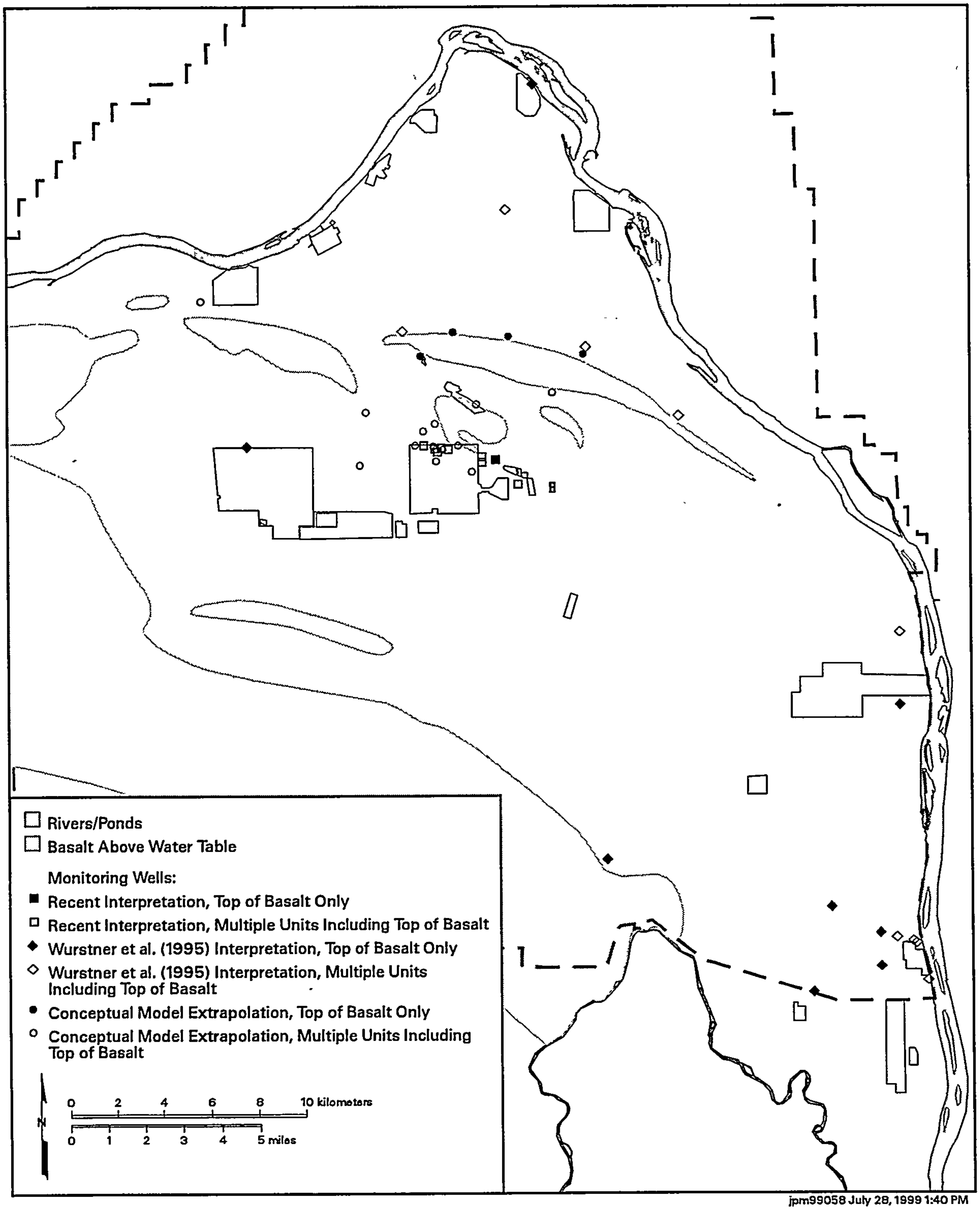

Figure 3.15. Water-Level Monitoring Network for the Top of the Uppermost Basalt Flow

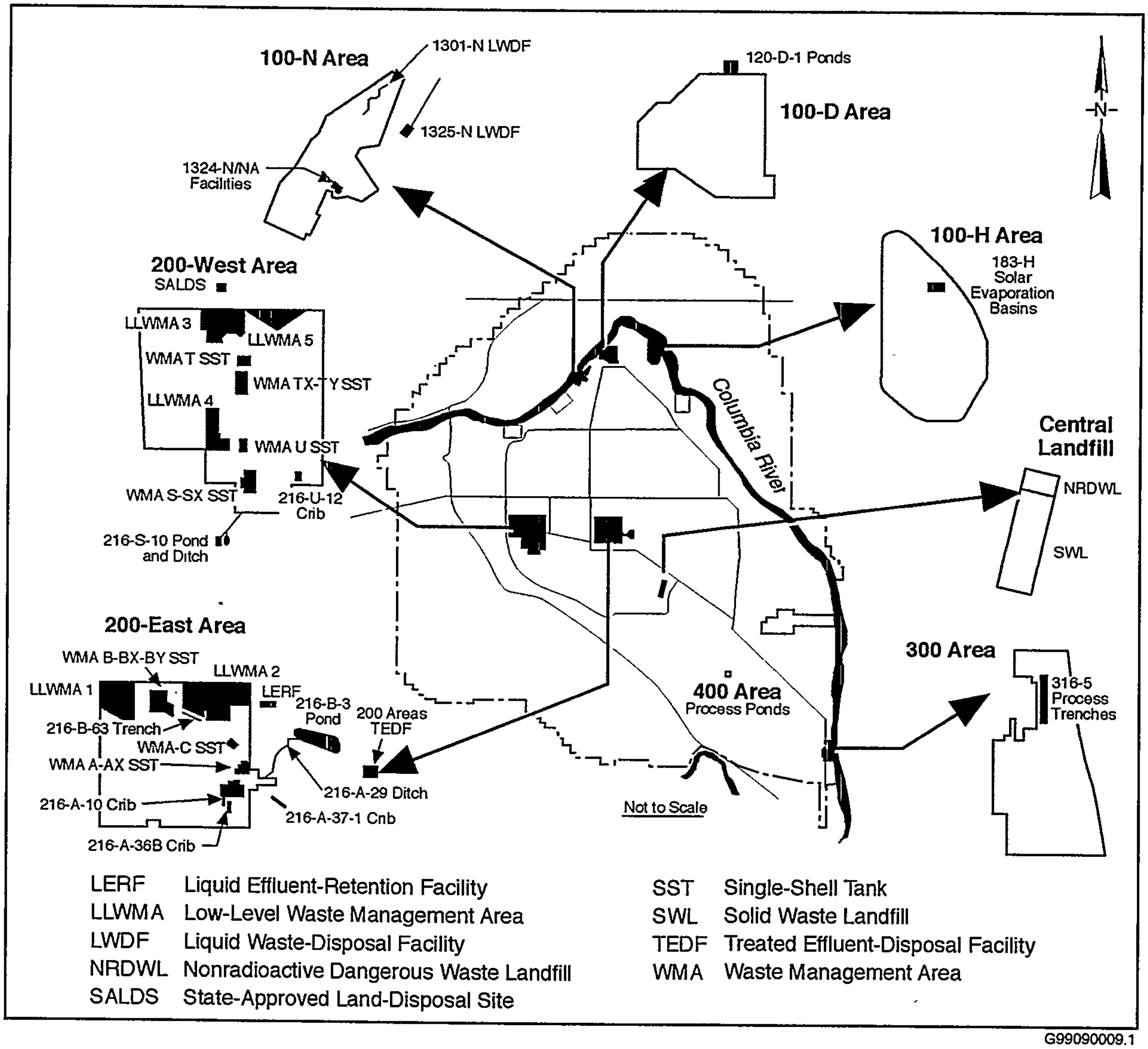

Figure 3.16. Regulated Units on the Hanford Site Requiring Water-Level Monitoring

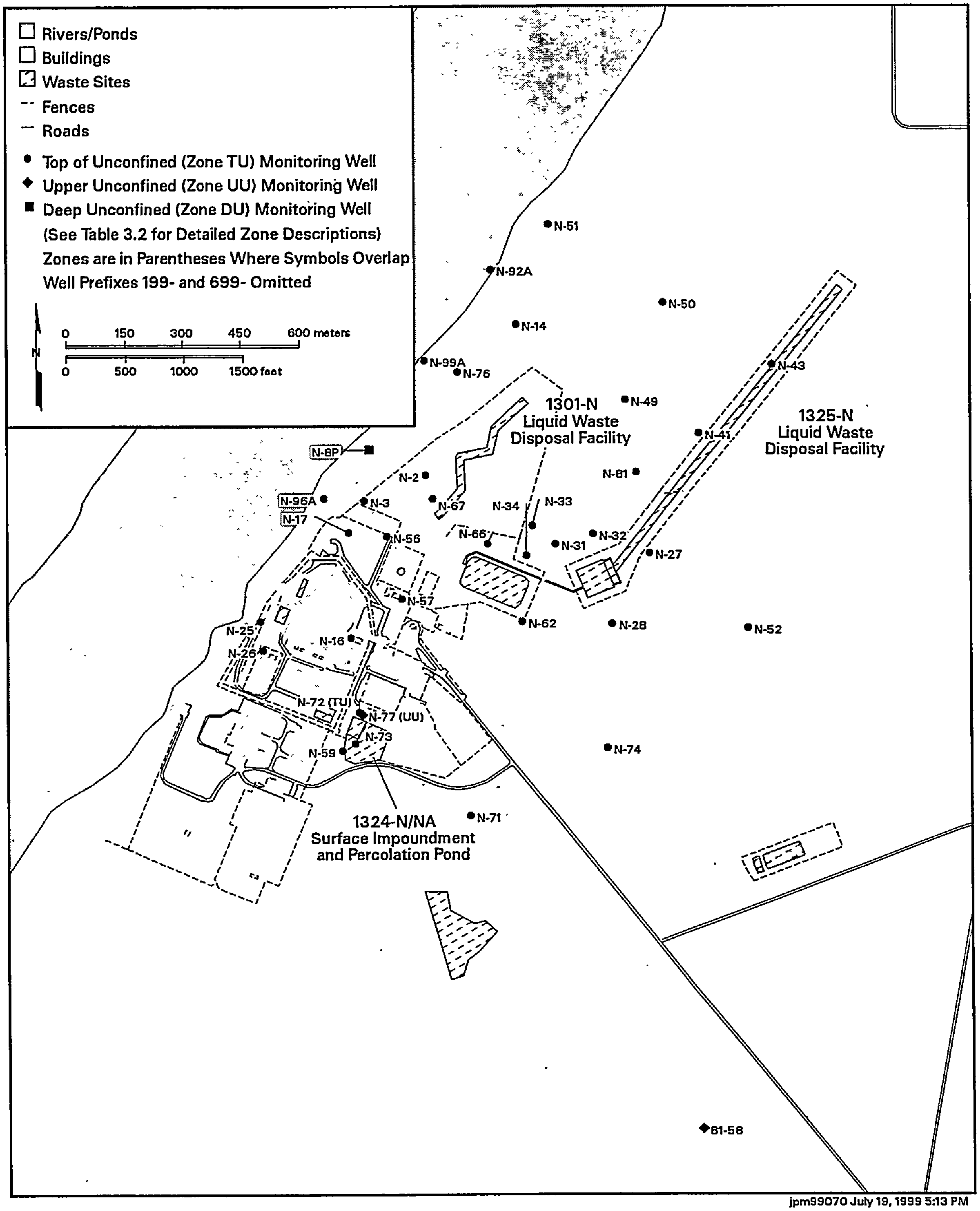

Figure 3.17. Water-Level Monitoring Network for the 1324-N/NA Facility, 1301-N Liquid Waste Disposal Facility, and 1325-N Liquid Waste Disposal Facility in the 100-N Area

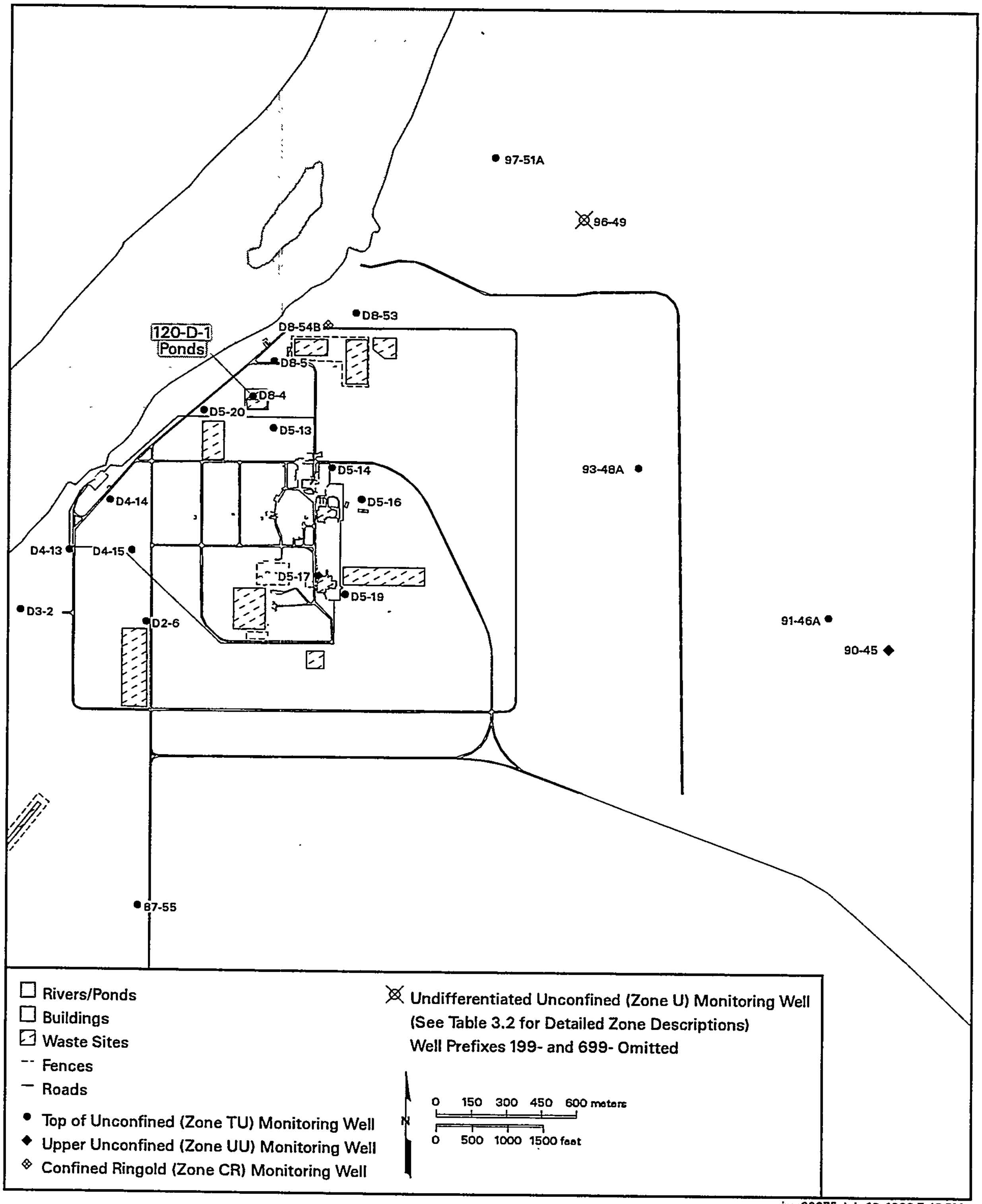

Figure 3.18. Water-Level Monitoring Network for the 120-D-1 Ponds in the 100-D Area

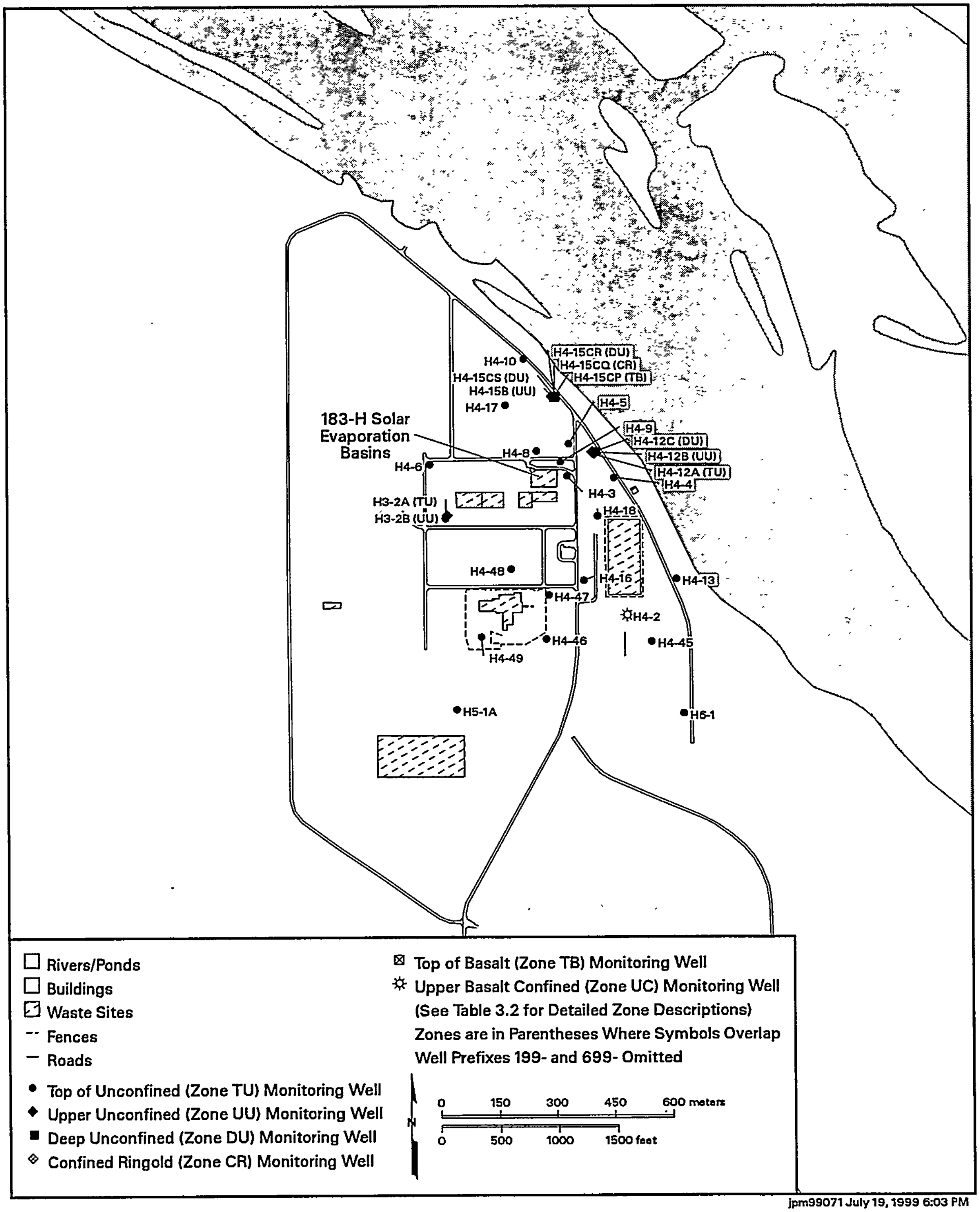

Figure 3.19. Water-Level Monitoring Network for the 183-H Solar Evaporation Basins in the 100-H Area

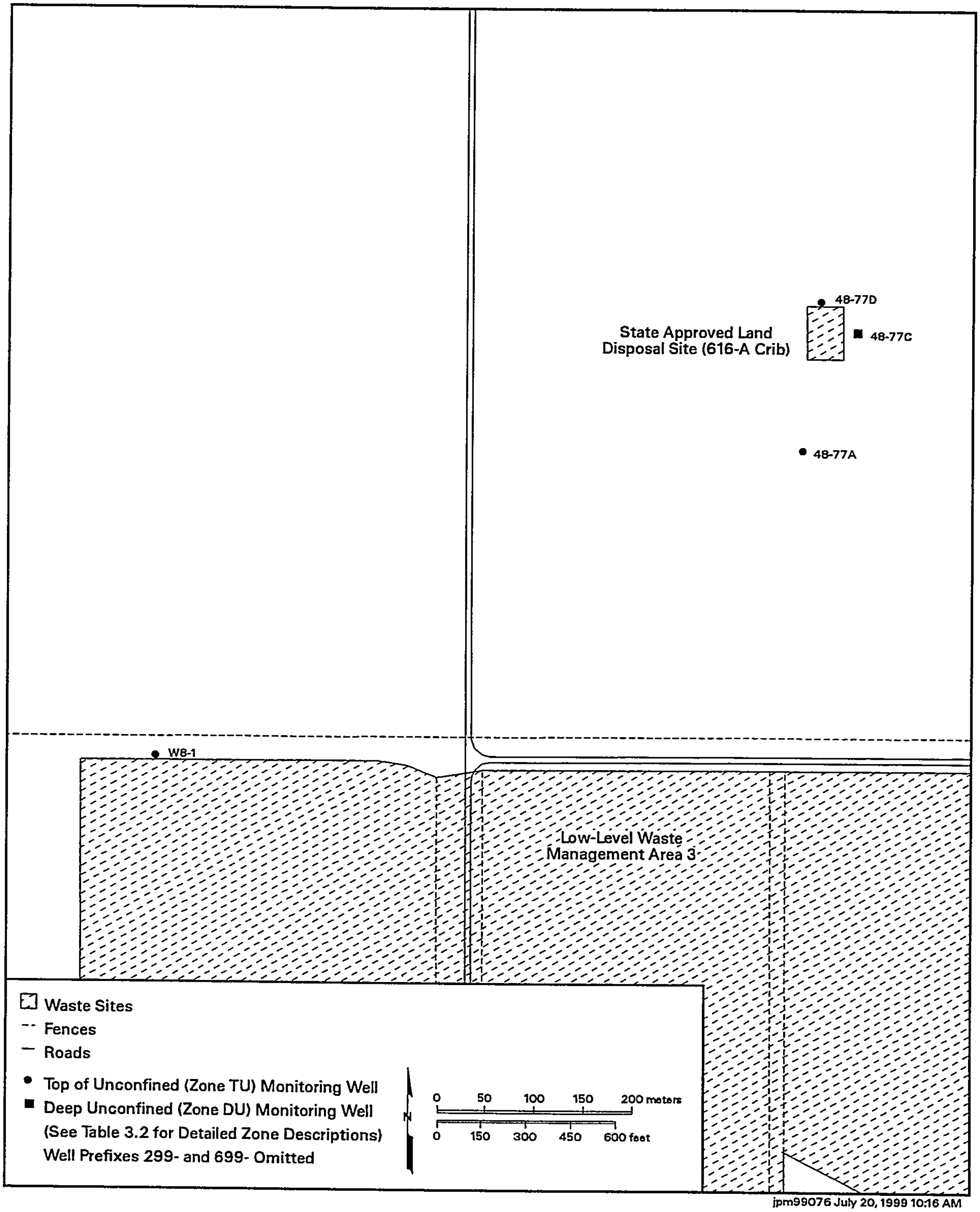

Figure 3.20. Water-Level Monitoring Network for the State Approved Land Disposal Site (616-A Crib) Near the 200-West Area

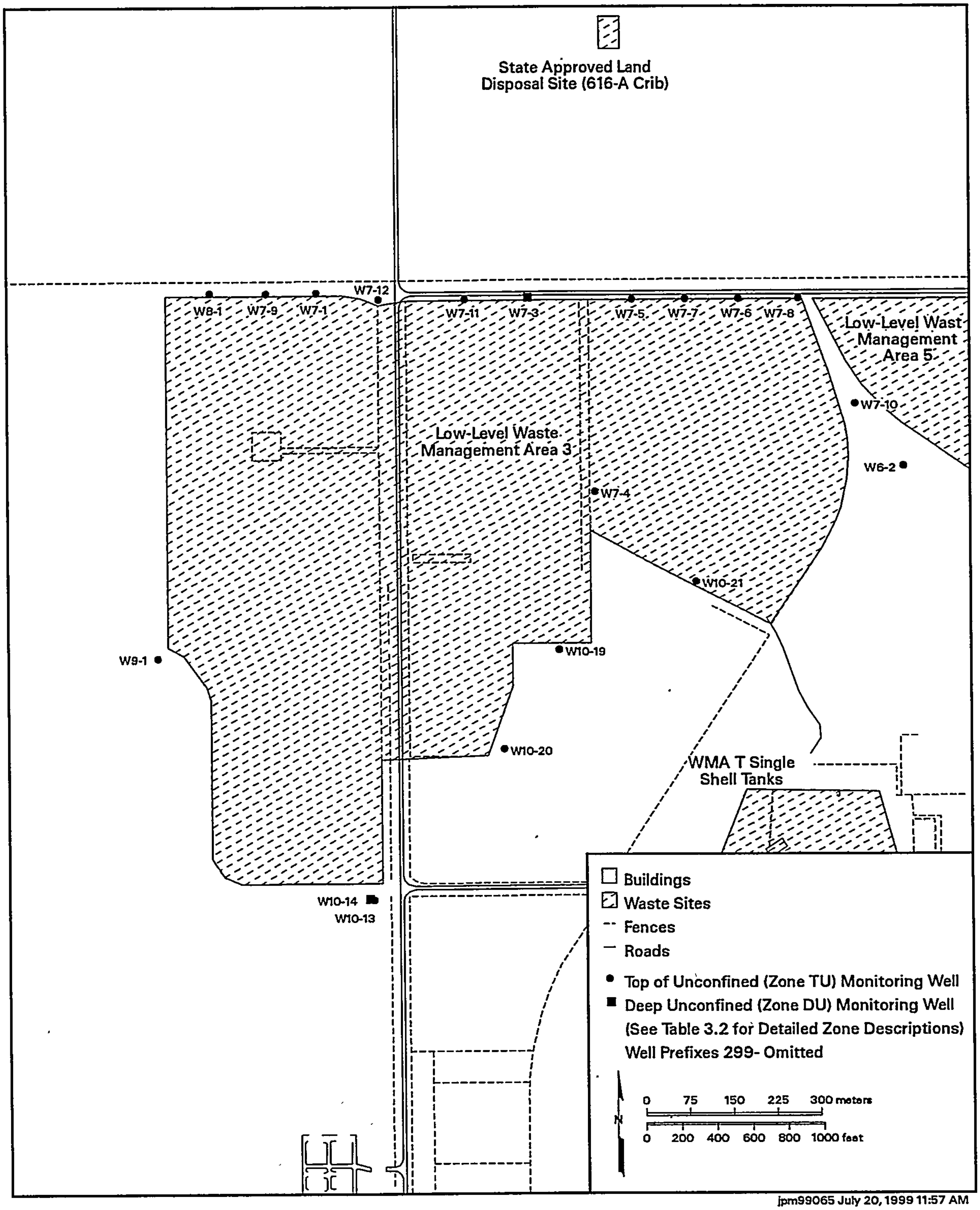

Figure 3.21. Water-Level Monitoring Network for Low-Level Waste Management Area 3 in the 200-West Area

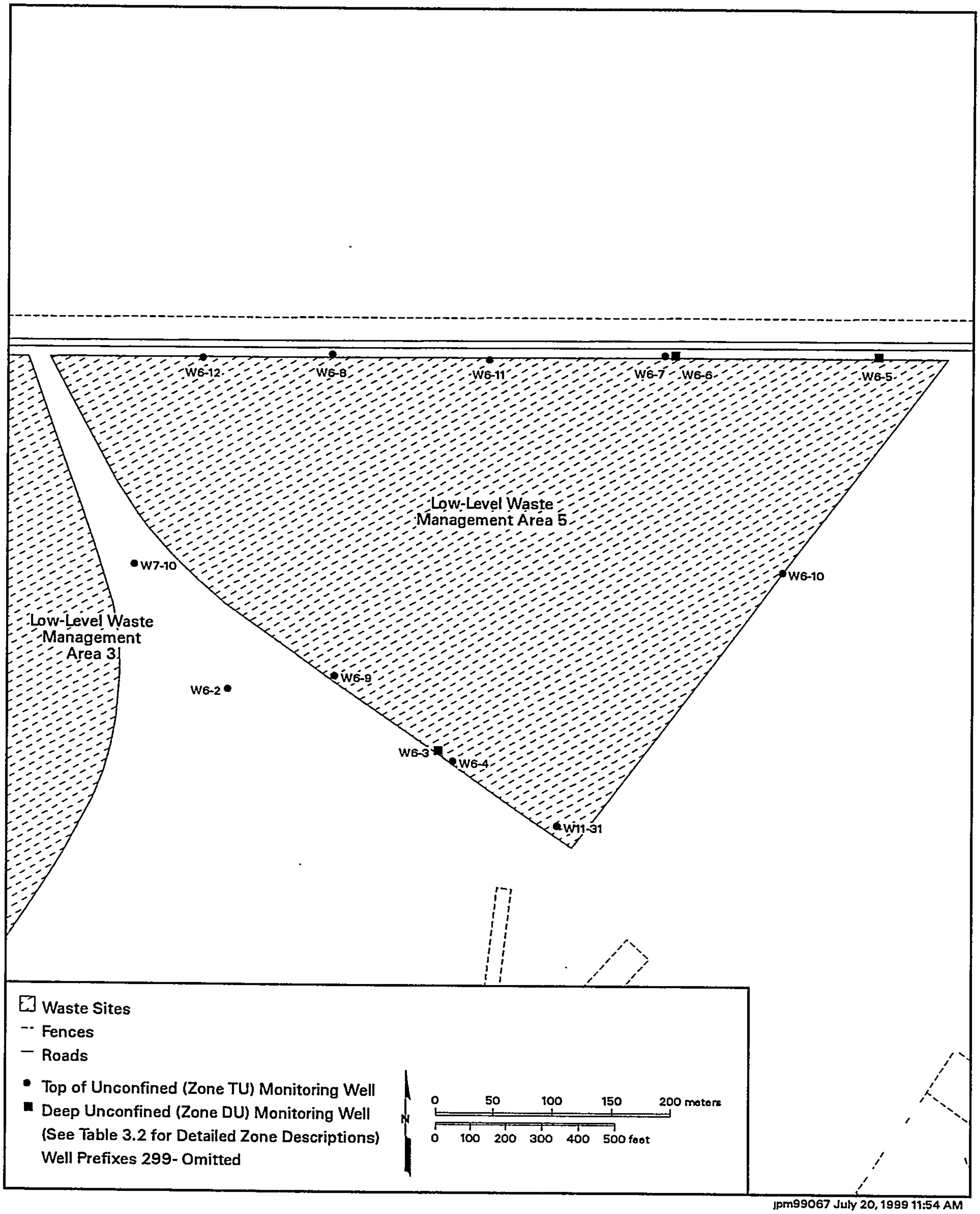

Figure 3.22. Water-Level Monitoring Network for Low-Level Waste Management Area 5 in the 200-West Area

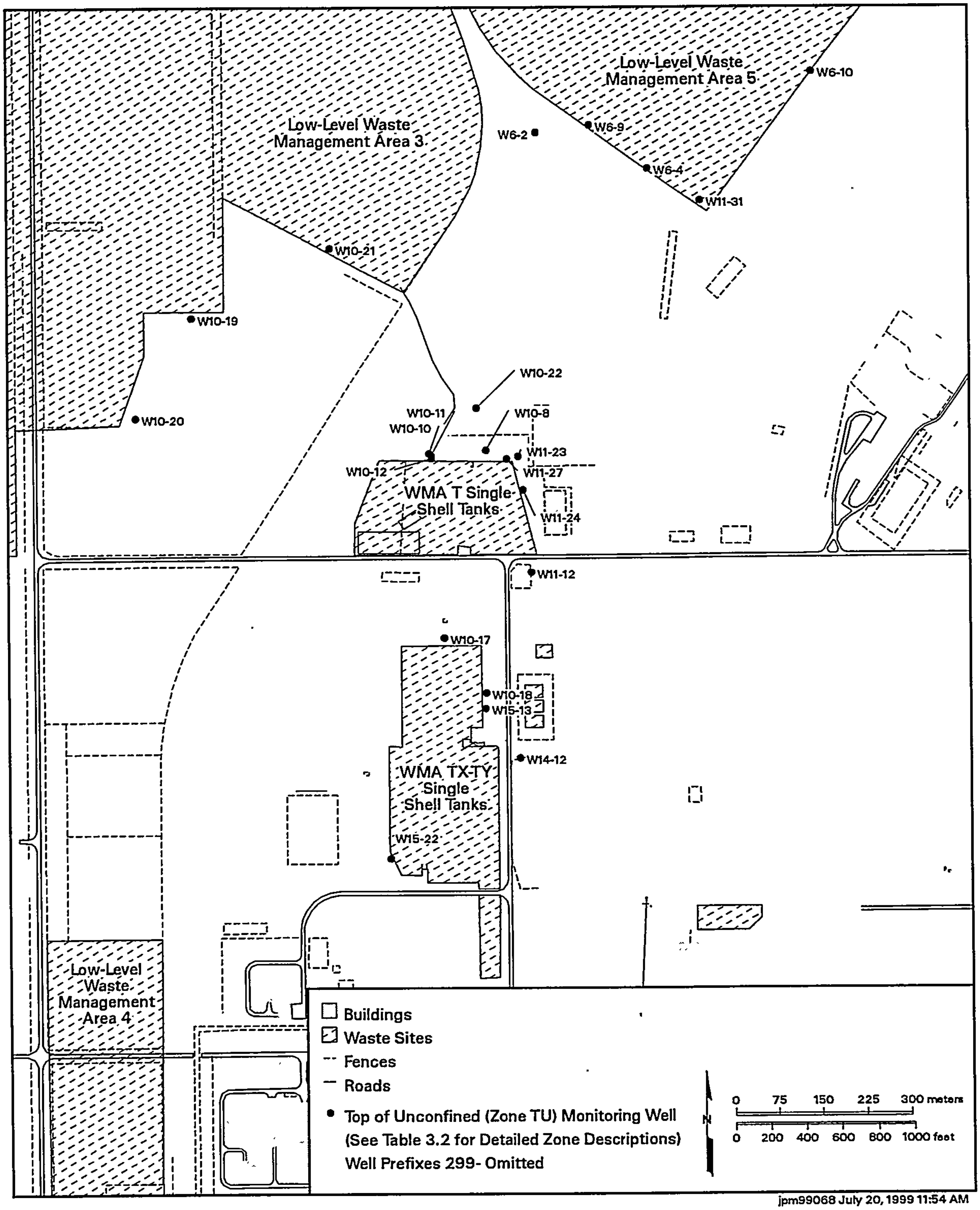

Figure 3.23. Water-Level Monitoring Network for the T, TX, and TY Single-Shell Tank Farms in the 200-West Area

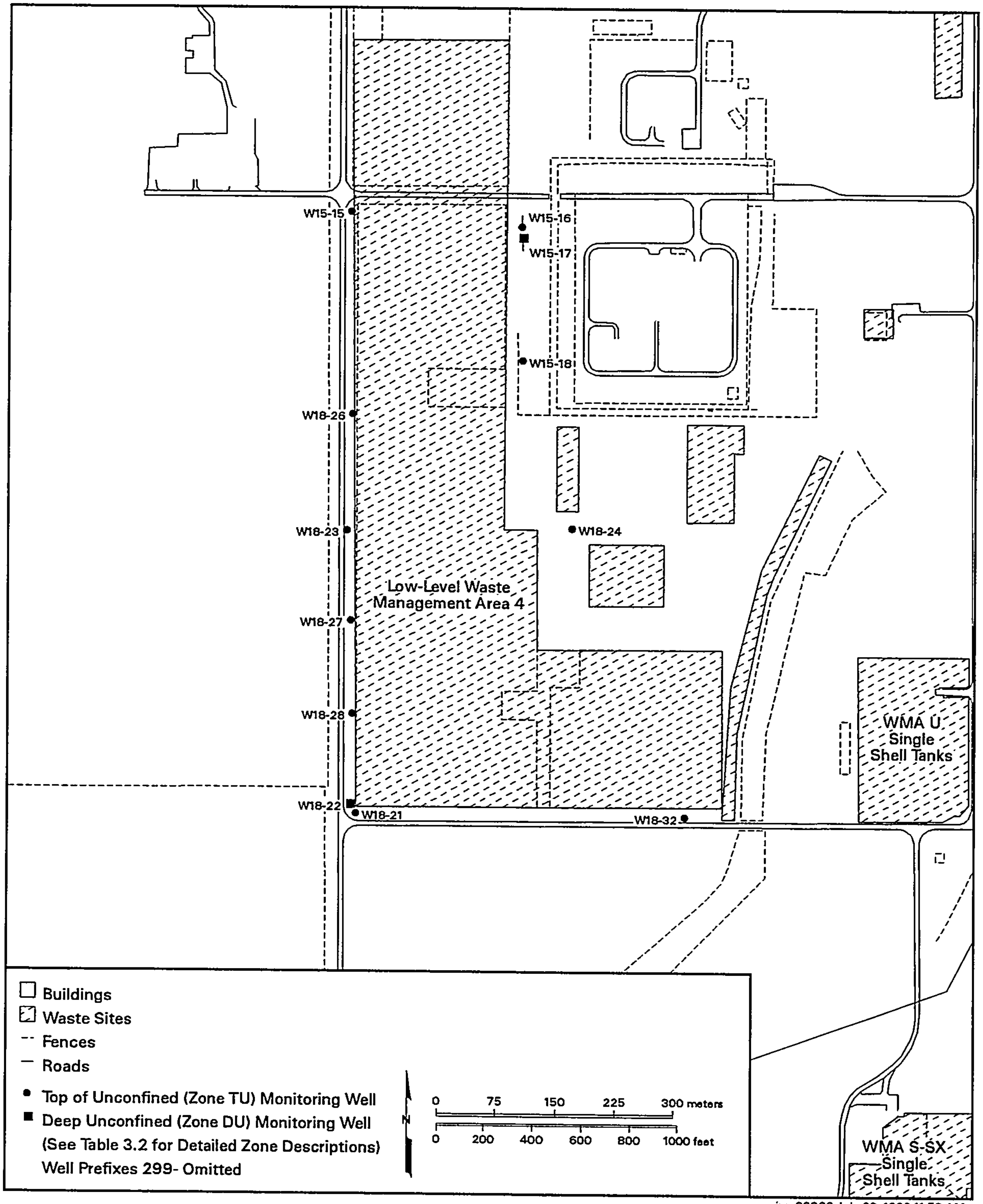

Figure 3.24. Water-Level Monitoring Network for Low-Level Waste Management Area 4 in the 200-West Area

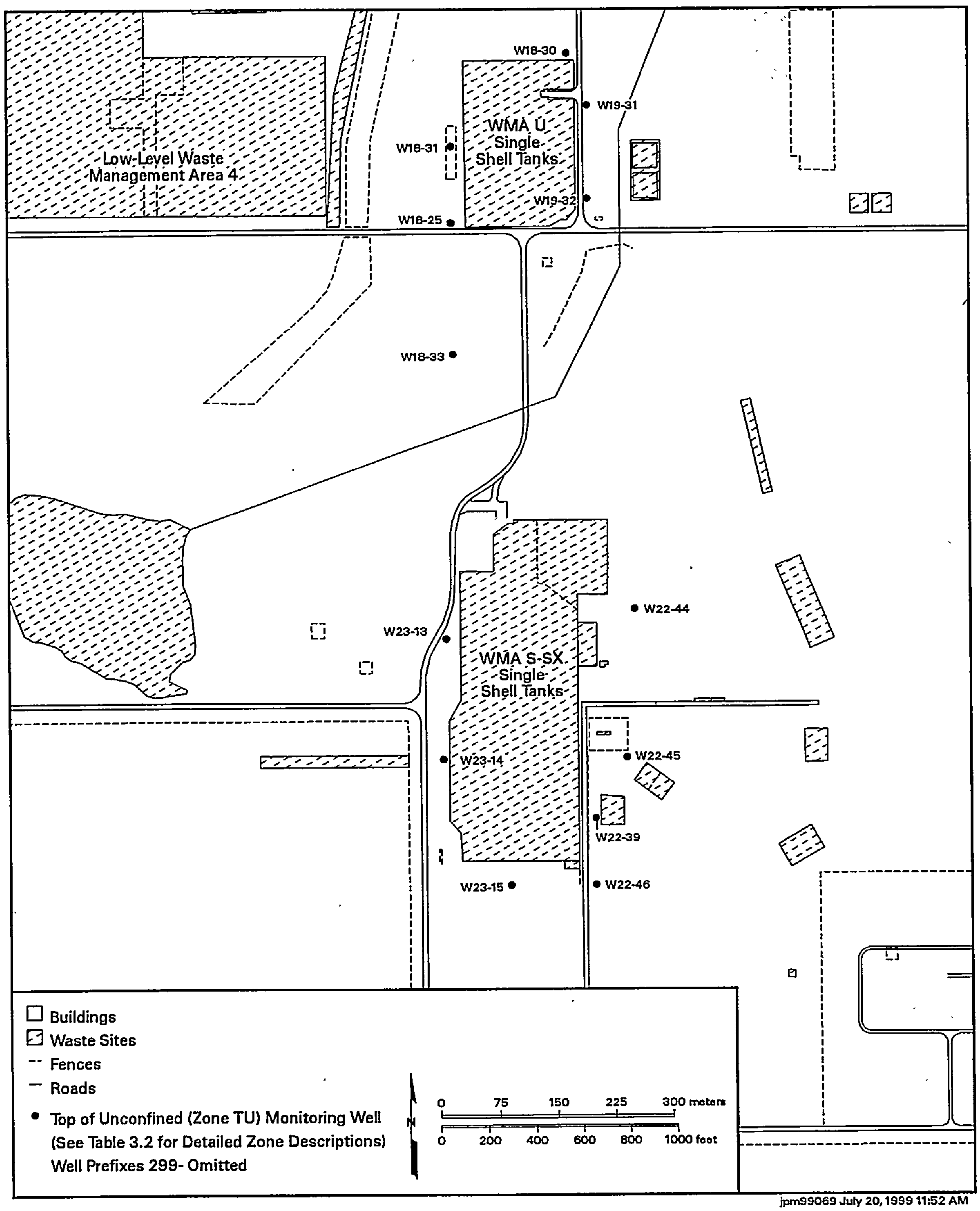

Figure 3.25. Water-Level Monitoring Network for the U, S, and SX Single-Shell Tank Farms in the 200-West Area

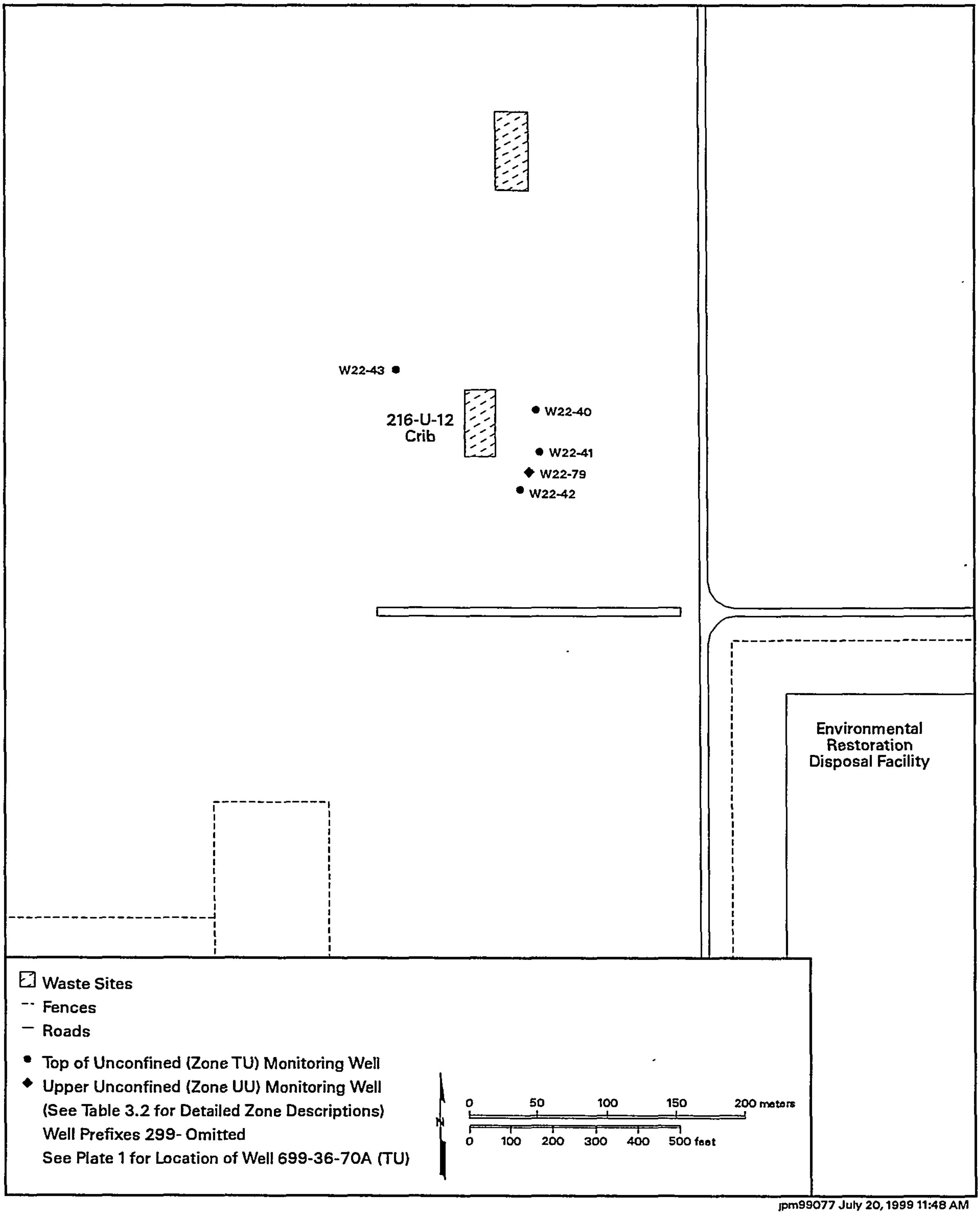

Figure 3.26. Water-Level Monitoring Network for the 216-U-12 Crib in the 200-West Area

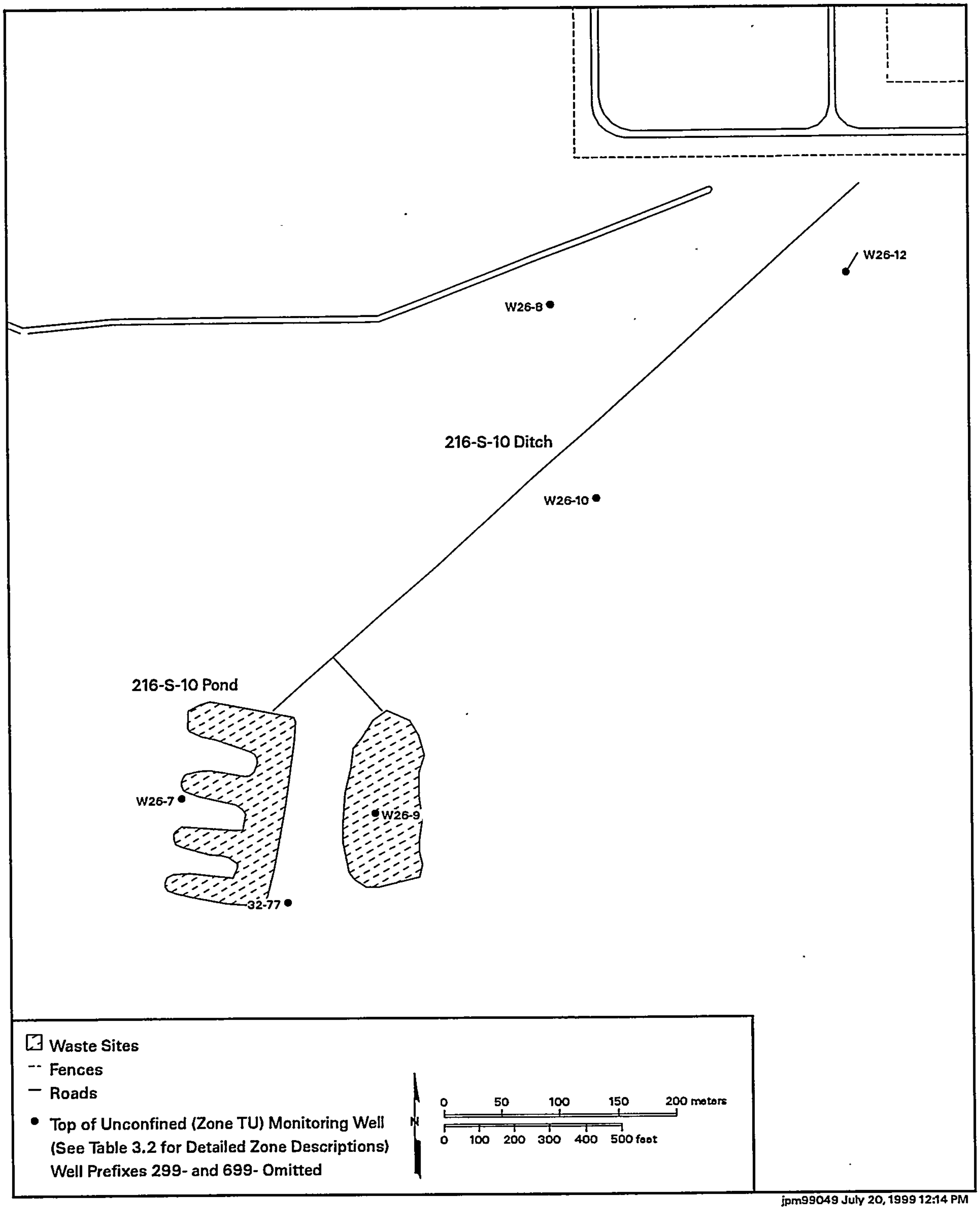

Figure 3.27. Water-Level Monitoring Network for the 216-S-10 Pond and Ditch in the 200-West Area

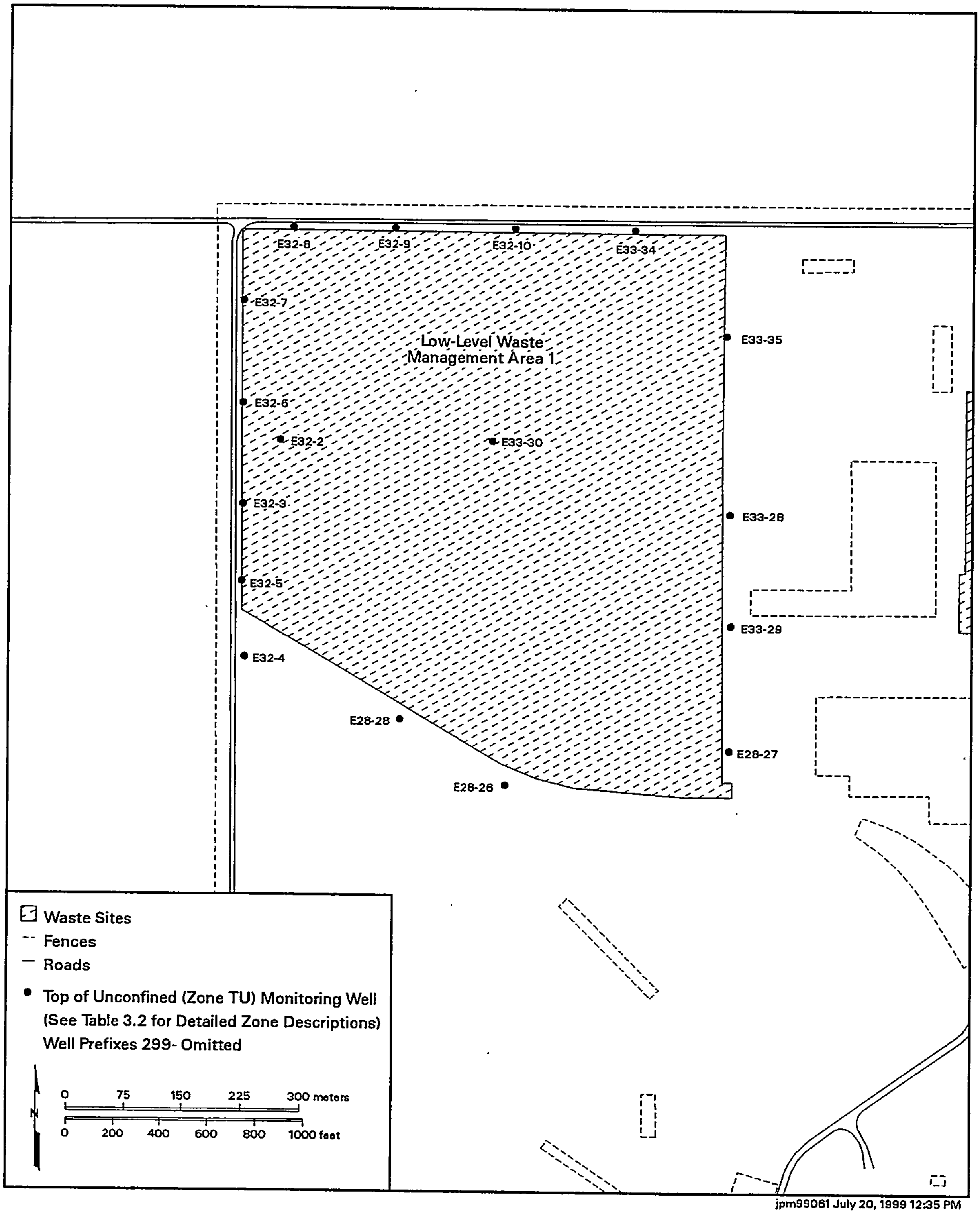

Figure 3.28. Water-Level Monitoring Network for Low-Level Waste Management Area 1 in the 200-East Area

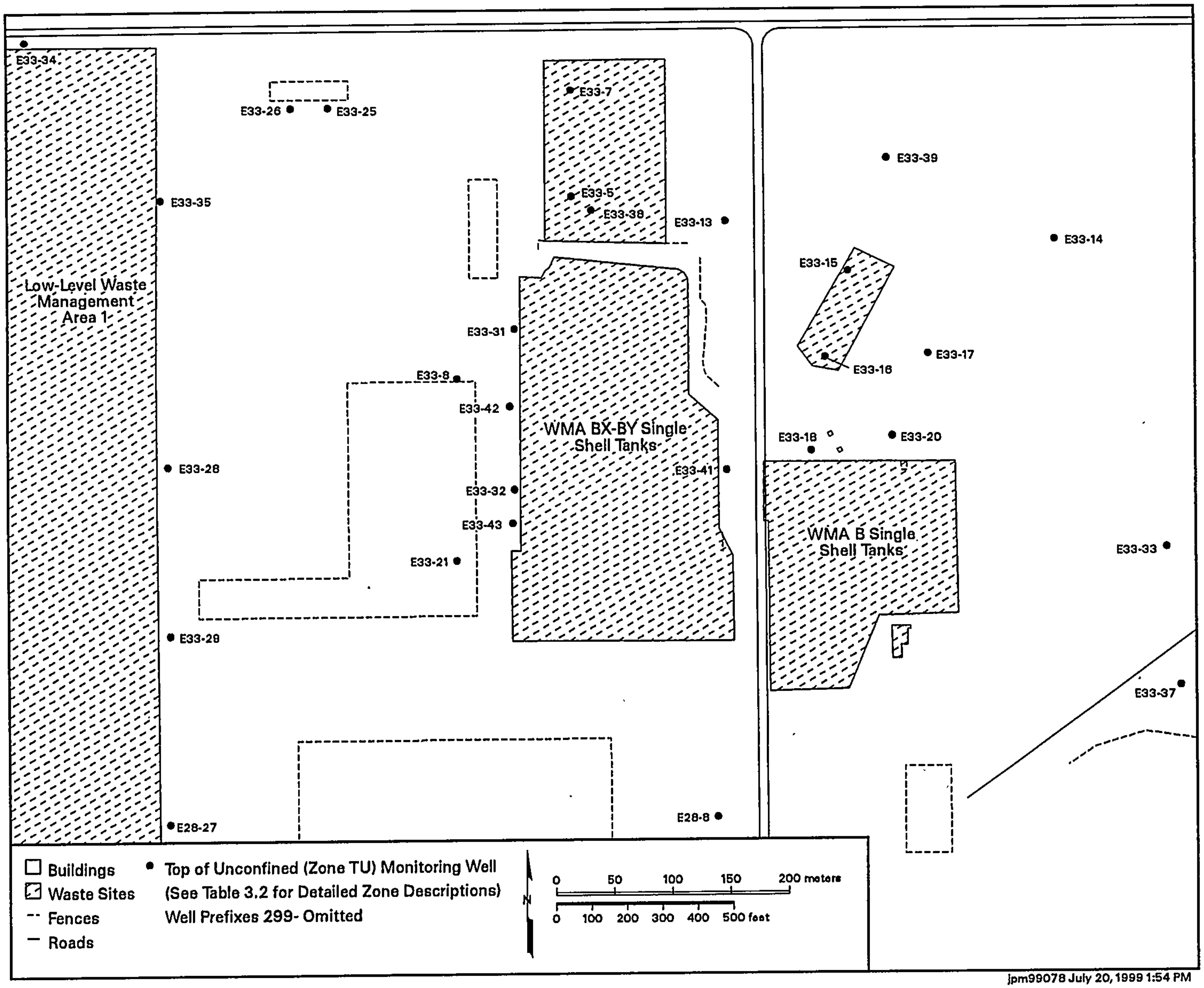

Figure 3.29. Water-Level Monitoring Network for the B, BX, and BY Single-Shell Tank Farms in the 200-East Area

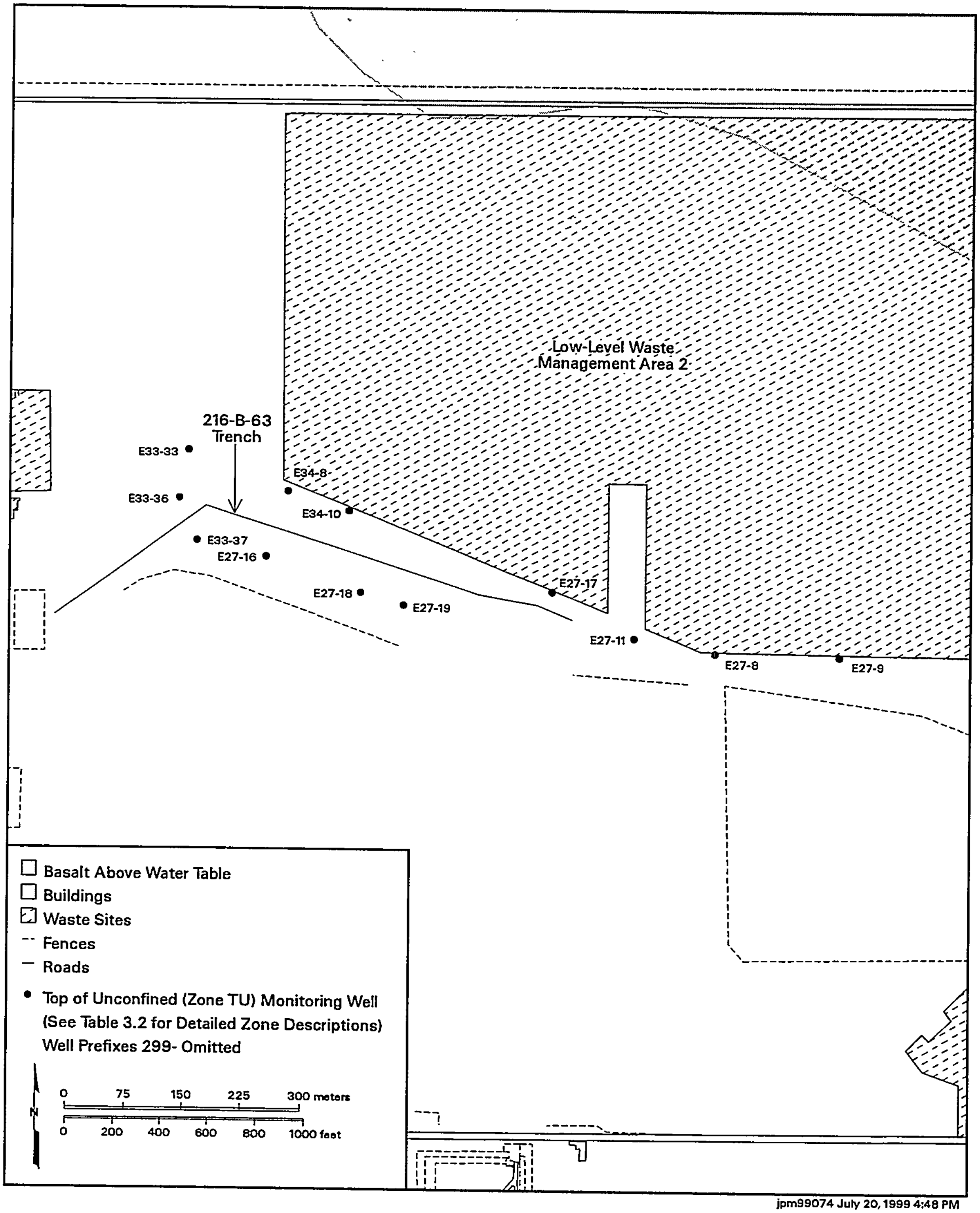

Figure 3.30. Water-Level Monitoring Network for the 216-B-63 Trench in the 200-East Area

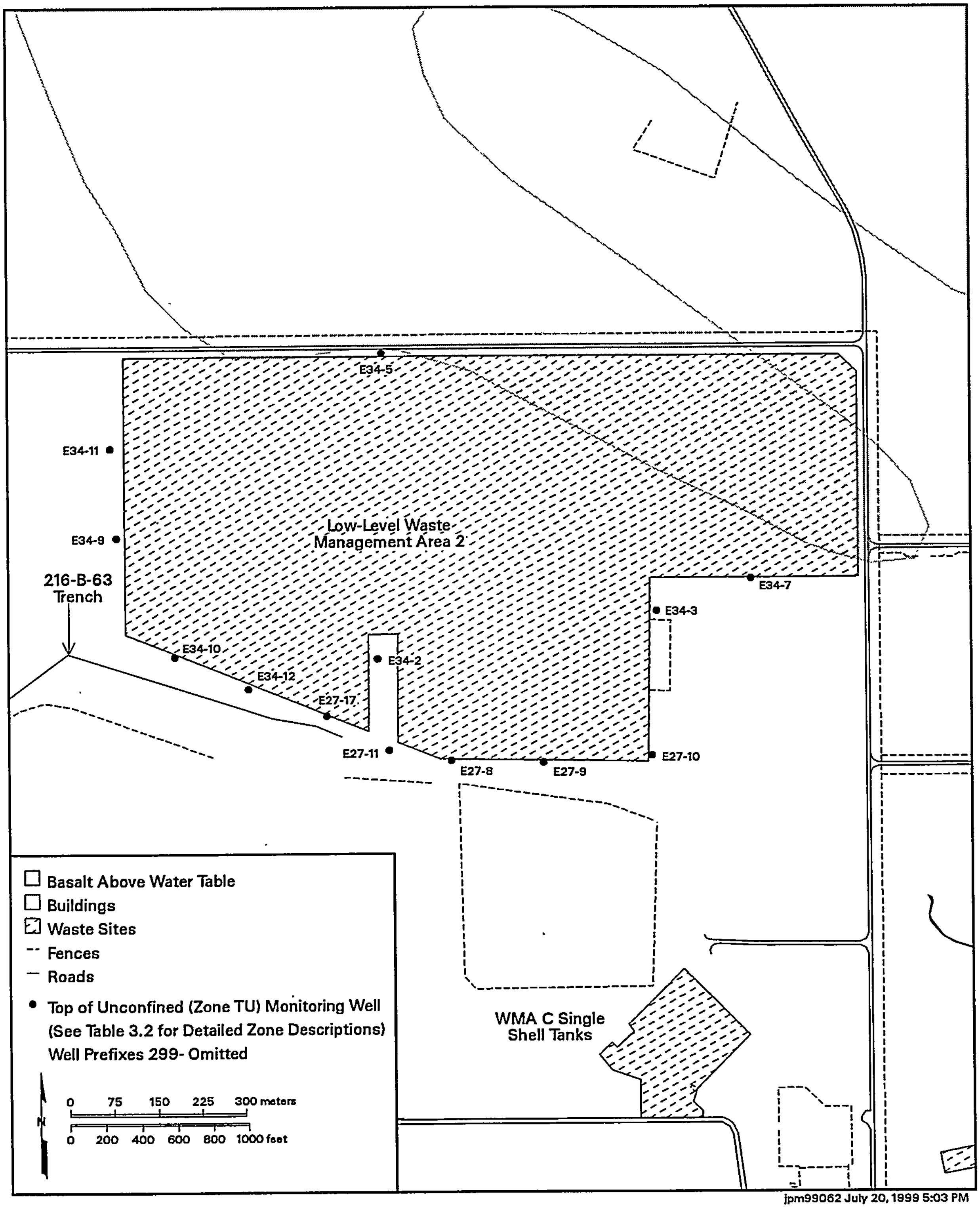

Figure 3.31. Water-Level Monitoring Network for Low-Level Waste Management Area 2 in the 200-East Area

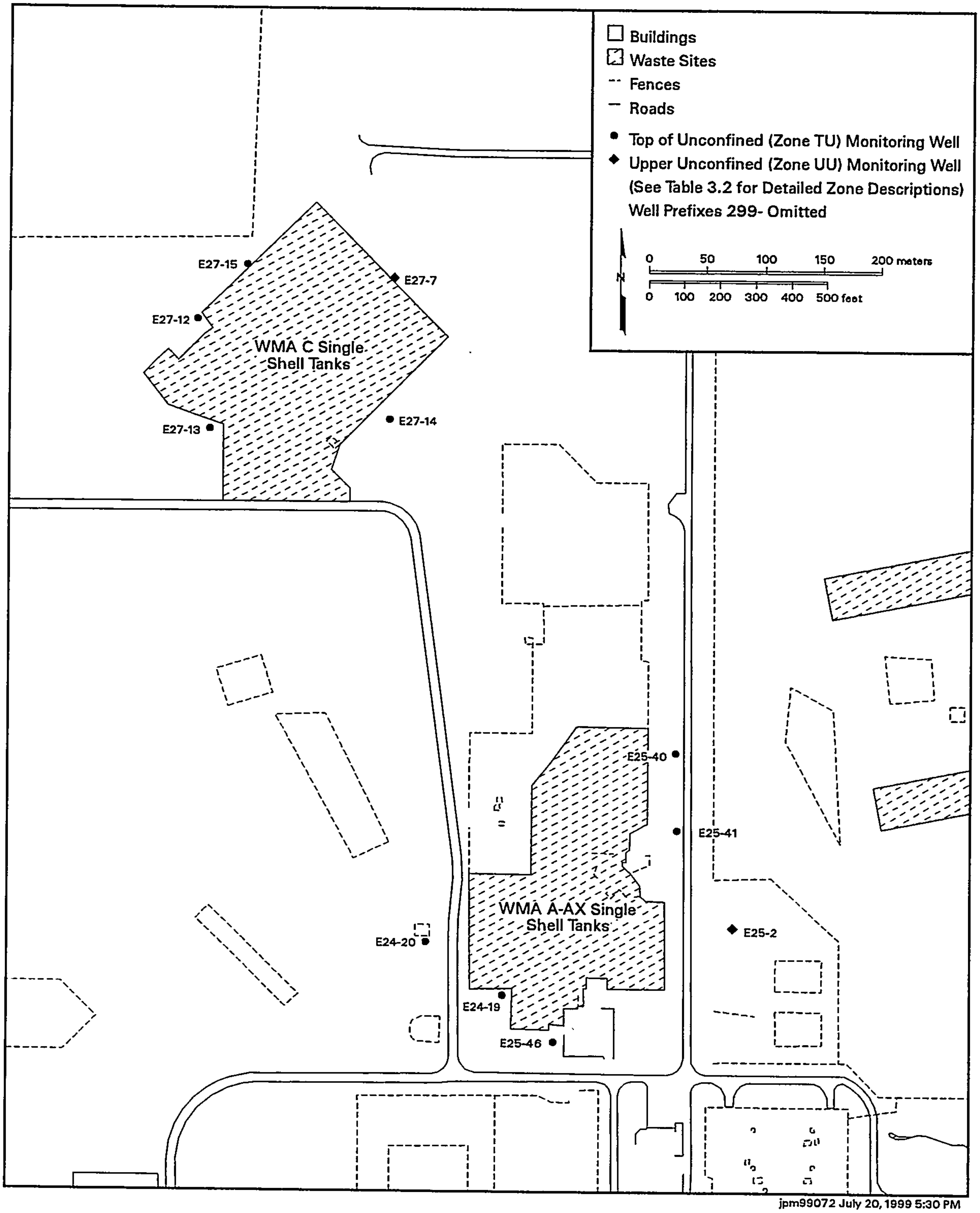

Figure 3.32. Water-Level Monitoring Network for the C, A, and AX Single-Shell Tank Farms in the 200-East Area

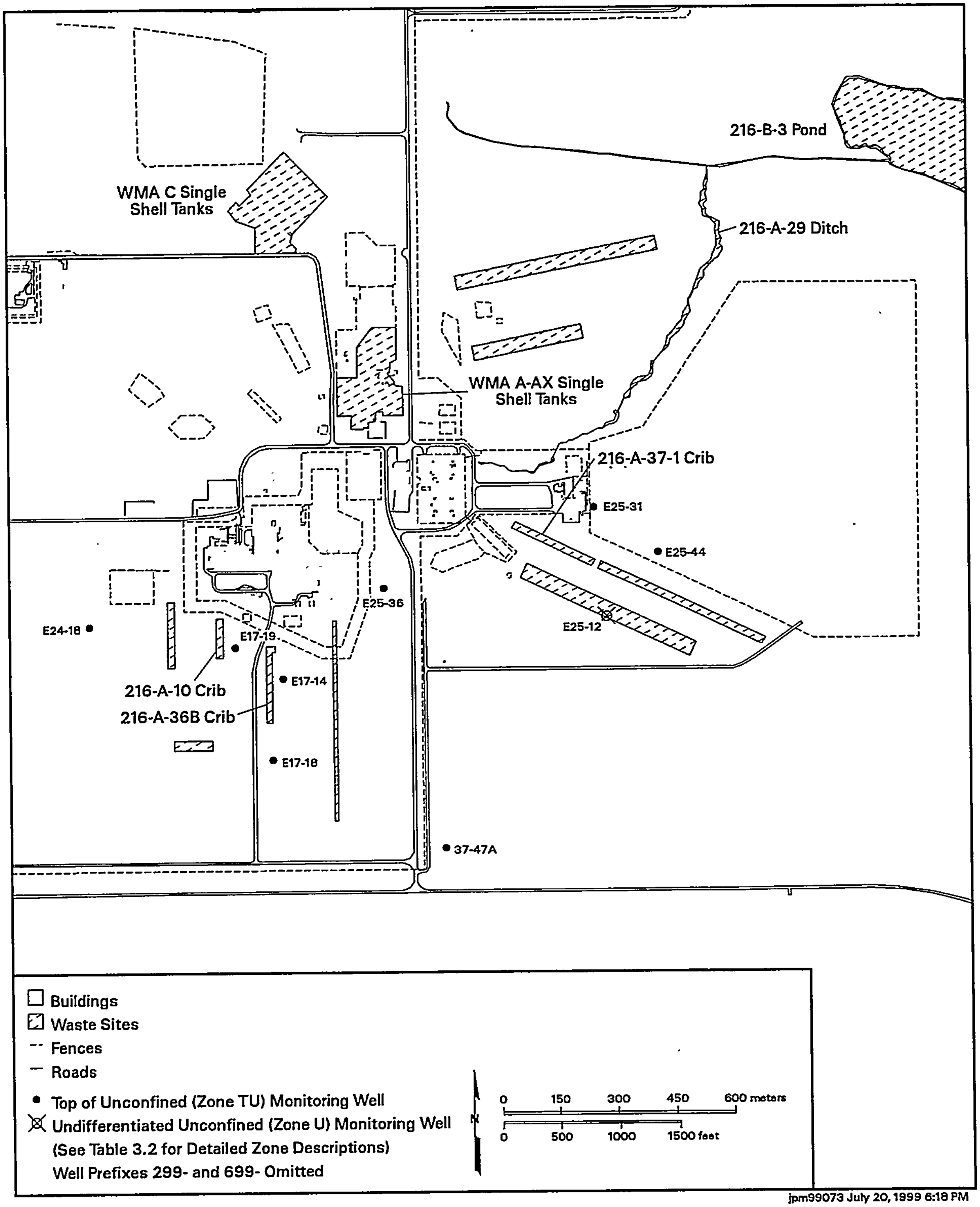

Figure 3.33. Water-Level Monitoring Network for the 216-A-36B, 216-A-10, and 216-A-37-1 Cribs in the 200-East Area

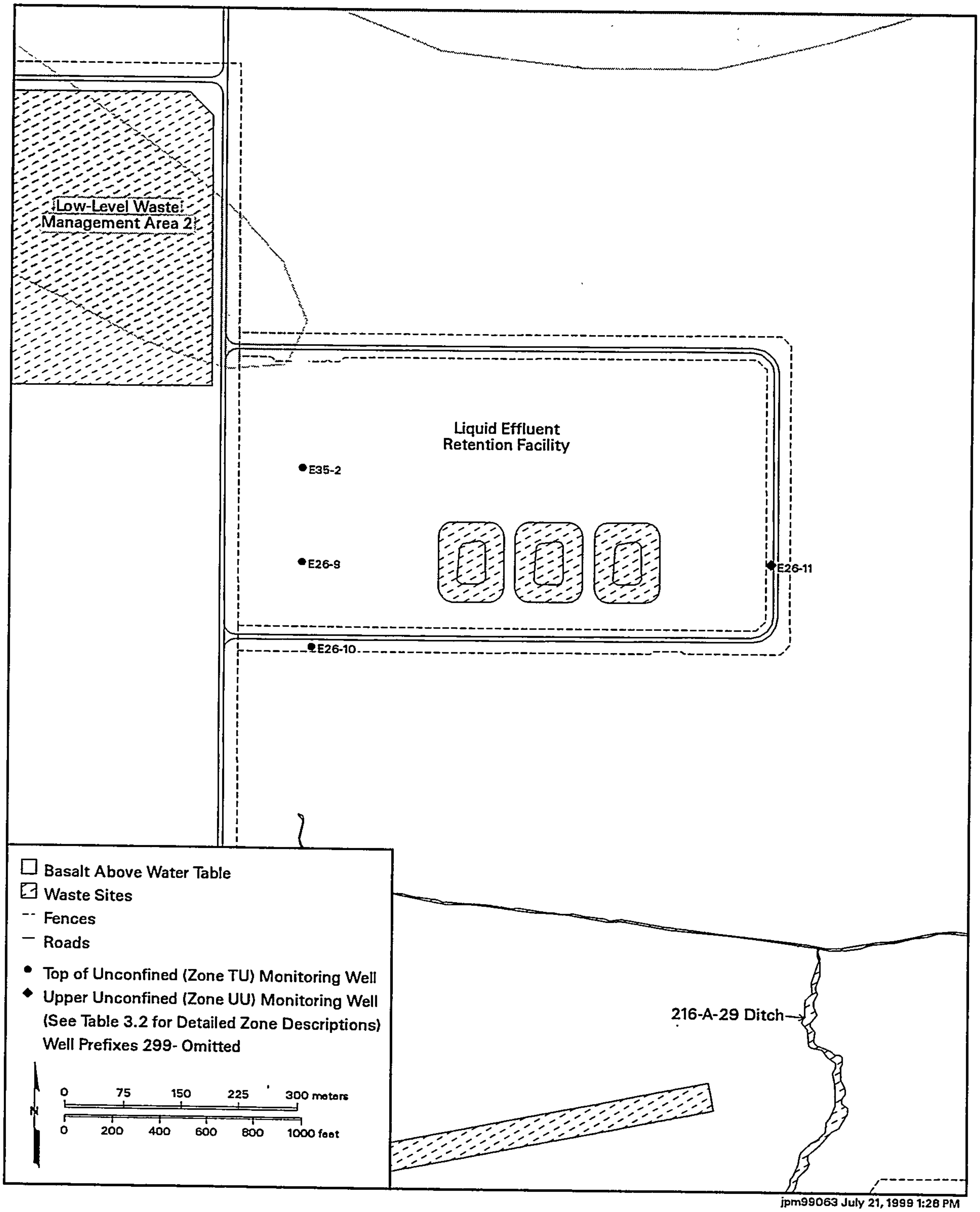

Figure 3.34. Water-Level Monitoring Network for the Liquid Effluent Retention Facility Near the 200-East Area

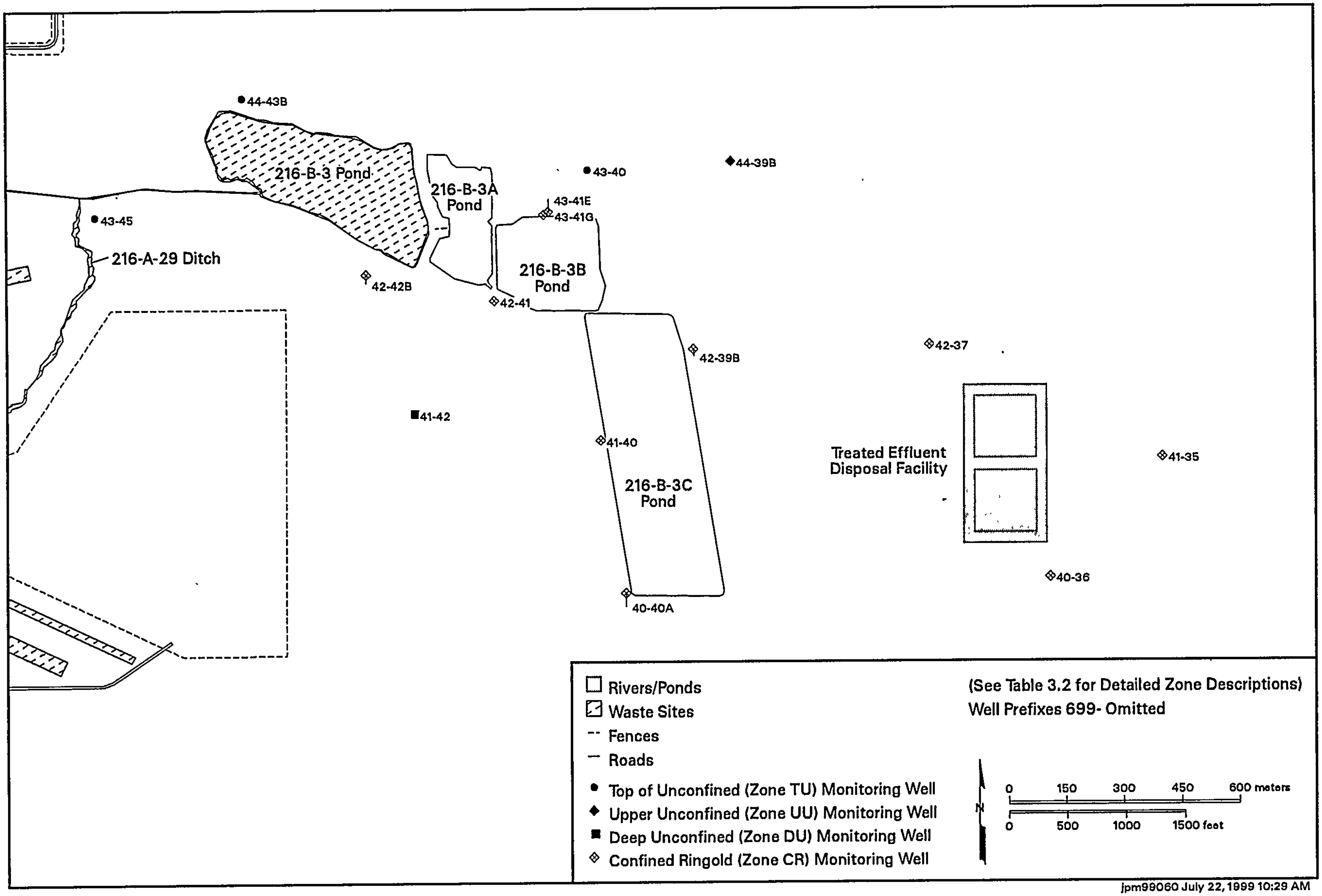

Figure 3.35. Water-Level Monitoring Network for the 216-B-3 Pond and the 200 Areas Treated Effluent Disposal Facility Near the 200-East Area

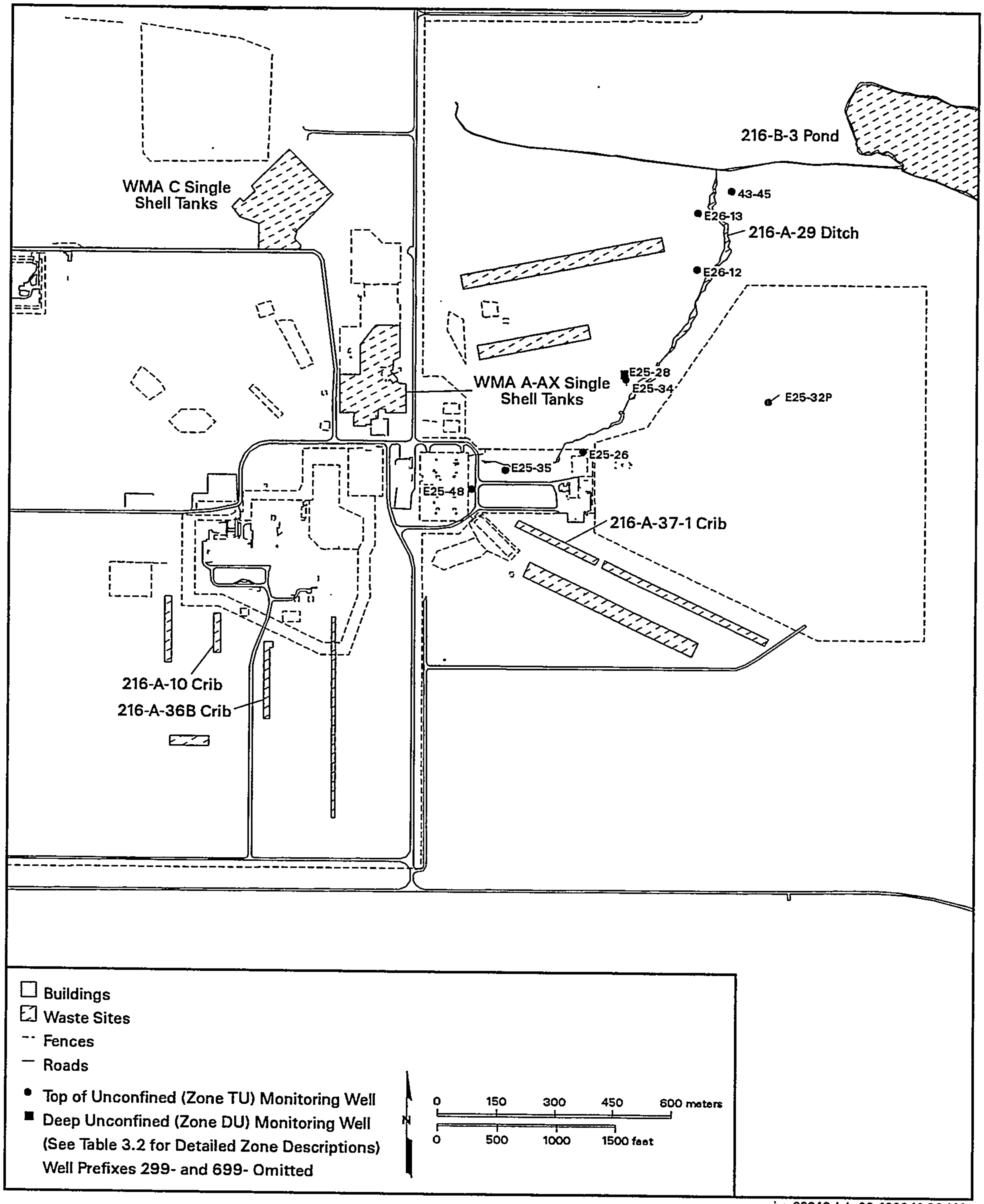

Figure 3.36. Water-Level Monitoring Network for the 216-A-29 Ditch Near the 200-East Area

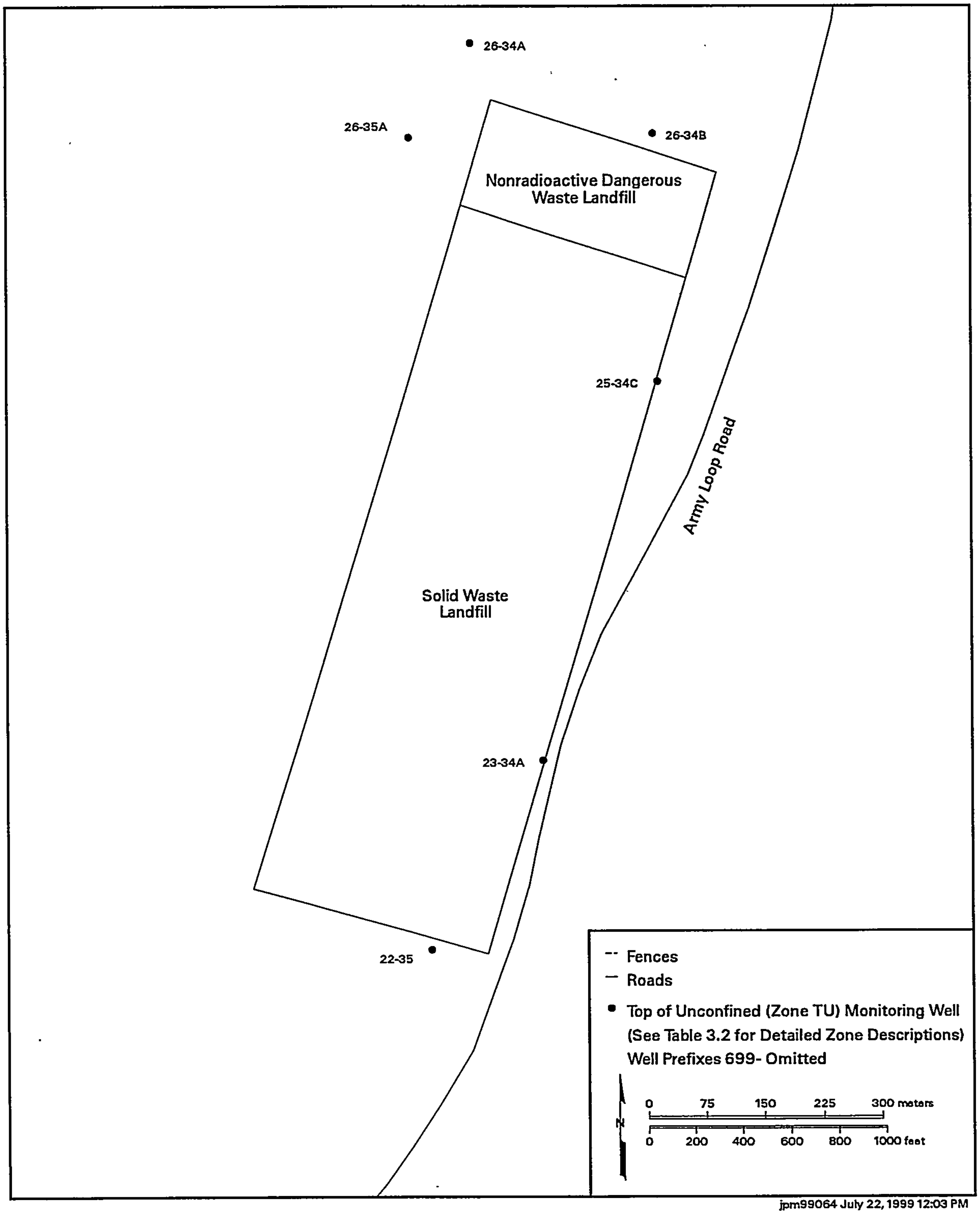

Figure 3.37. Water-Level Monitoring Network for the Solid Waste and Non-Radioactive Dangerous Waste Landfills Southeast of the 200-East Area

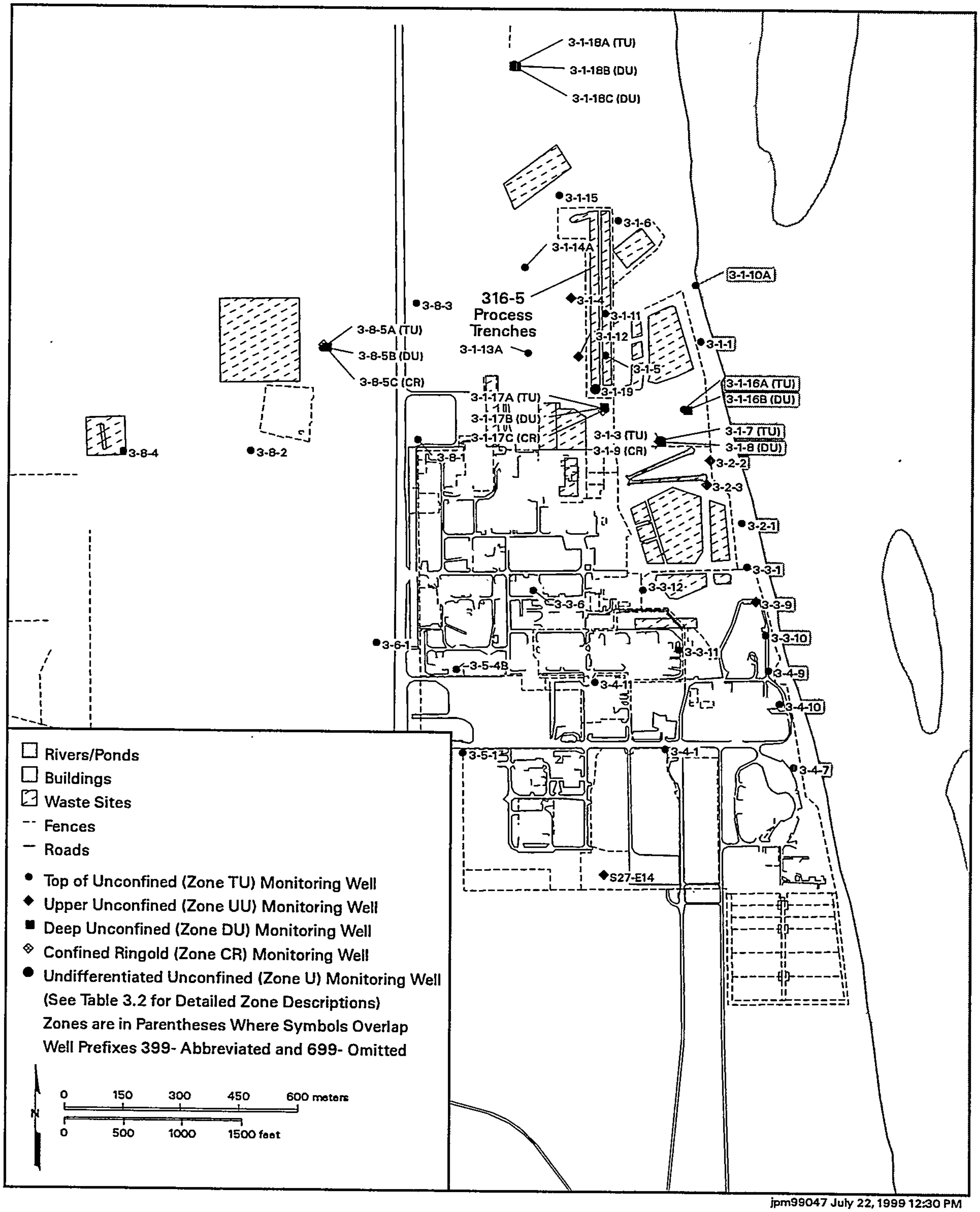

Figure 3.38. Water-Level Monitoring Network for the 316-5 Process Trenches in the 300 Area

4.0 Data Evaluation

This section discusses issues relating to the quality of water-level data collected by the groundwater project, and describes how these data are managed, analyzed, and reported.

4.1 Data Quality

To be useful for preparation of water-table and potentiometric-surface maps, and for determining the direction and velocity of groundwater flow, water-level measurements must be accurate and temporally representative (i.e., the measurements should be taken over as short a time period as possible). This section describes the various sources of error and uncertainty that limit the accuracy and representativeness of water-level data, and explains the strategy employed by the groundwater project to minimize this error.

Error and uncertainty affecting water-level data result from temporal-external stress effects, well design and construction, geodetic survey limitations, instrument limitations, and measurement techniques. Specific sources of error and uncertainty due to temporal-external stress effects include

- temporal changes in the water table or potentiometric surface over the time period in which manual water-level measurements are made

- temporal changes in the water-level in a well due to barometric pressure fluctuations that do not affect the actual water table or potentiometric surface, or cause an effect only after a time lag.

Issues associated with well construction and design are

- vertical gradients along the length of the screened interval in a well
- inadequate hydraulic isolation of the monitored interval
- deviations of the well borehole from vertical.

Geodetic survey issues include

- accuracy of the reference vertical datum in representing elevations above mean sea level (i.e., the geoid - a surface of equal gravitational potential)

- errors in surveyed reference-point elevations.

Sources of error due to instrument limitations or measurement technique include

- errors in application of the reference point/measurement point offset correction
- limits of measuring device precision and accuracy
- measurement transcription errors.

The degree to which these errors affect the interpretation of water-level data depend on the hydraulic gradient. Where the horizontal gradient is high (>0.001) (e.g., east of the 200-West Area in Figure 2.2), small measurement errors have little effect on contour map generation or velocity calculations. Where the horizontal gradient is low (<0.001) (e.g., the 200-East Area in Figure 2.2), small measurement errors can have a large effect on determining flow direction and velocity. Similarly, where vertical gradients are large, small measurement errors have little effect on discerning the vertical flow component, but measurement error becomes important where vertical gradients are small. Therefore, the strategy employed for data collection, as well as the data collection procedures themselves (Section 3.1), are designed to minimize the error associated with water-level measurements.

4.1.1 Temporal-External Stress Effects

Fluctuations in the water table or potentiometric surface can be caused by several natural and manmade stresses such as barometric pressure changes, changes in river stage, seasonal variation in natural recharge, irrigation practices, wastewater disposal practices, and groundwater withdrawal/ injection. To reduce the effect of seasonal and other long-term water-level changes in representing water tables and potentiometric surfaces, and in discerning flow-system changes over time, annual surveillance water-level measurements are made within the same 1-month period every year (Section 3.2.1). In addition, barometric pressure fluctuations cause water levels in wells to change instantaneously, but may not cause a change in the water table, or this change occurs after a time lag, because the overlying sediments restrict the propagation of these pressure fluctuations to the water table. For this reason, the water-level elevation in a well may not be equal to the actual water-table elevation. Efforts are ongoing by the project to develop and implement a method to correct for the effect of temporal barometric pressure fluctuations.

The most significant short-term water-level changes occur in wells influenced by fluctuations in Columbia River stage. These short-term water-level fluctuations introduce transient effects in representing the water table adjacent to the river. Therefore, the water-table elevation contours for this region have a lower confidence in representing a point-in-time water table. Water levels taken within individual operational areas adjacent to the river (i.e., the 100 Areas) are measured as close together in time as is possible to reduce the transient error. Efforts to develop a technique for discerning the average water-table elevation representative for a given period of time (e.g., a week or month) are in the planning stage by the groundwater project. To reduce the effect of short-term fluctuations on the regulated-unit measurements, water-level measurements are taken within a single day at individual sites, in accordance with Environmental Protection Agency guidance (NWWA/EPA 1986).

4.1.2 Well Design and Construction

For water-table measurements, the degree to which the water level in a well is representative of the water table depends on many factors, including the vertical gradient over the screened interval. If the hydraulic potential changes over the length of the screened interval, the water-level in that well will be a composite water level not representative of the water table. The best water-table measurements are obtained from wells that penetrate only 1 to 2 meters below the water table. By monitoring such a short interval, a significant vertical gradient is less likely to be encountered across the screened interval. However, such wells usually are impractical for long-term monitoring, because the water table may rise above or fall below the screened interval in a relatively short period of time. Most of the recently installed monitoring wells on the Hanford Site (since about the mid-1980s) typically have a 3 to 6 meters screened interval. Therefore, it is arbitrarily assumed that wells completed within the upper 10 m of the unconfined aquifer (zone TU) are generally suitable for water-table monitoring. It was shown in Section 3.2.2 that water levels in wells completed down to 15 meters beneath the water table (zone UU) provide water-level elevations that are nearly the same as in nearby TU wells. Therefore, wells completed down to 15 meters also are assumed to be acceptable for water-table measurements. To monitor the potentiometric surface for an aquifer or hydrogeologic unit, it is generally assumed that wells completed solely within that unit provide a hydraulic head representative of that unit.

Wells installed on the Hanford Site prior to the mid-1980s are not RCRA compliant, particularly wells outside of operational areas. Many of these wells have a carbon steel casing that is perforated over large vertical intervals. Therefore, wells perforated or screened over large intervals are used for water-table measurements only where there is no significant vertical gradient or no other nearby more suitable well exists. In some cases, plugs are installed in these wells to limit the effective perforated interval to the uppermost unconfined aquifer. These wells are assumed to provide representative water-table measurements. However, the integrity of the installed plugs is questionable, so these wells are evaluated on a case-by-case basis. Also, because these wells do not have bentonite or grout seals, the isolation of the uppermost aquifer is questionable, even with an intact plug. Wells having a large perforated interval that have been recompleted to monitor the uppermost aquifer, are currently included in the water-table monitoring well network. However, these wells will be evaluated in the coming years, and those deemed to be unsuitable for water-table monitoring will be removed from the network.

Deviation of the well borehole from vertical is only significant in areas of very low gradients (e.g., the 200-East Area). In these areas, most sources of error probably need to be quantified and corrected for, in order to discern gradients using water-level data. To date, water-level measurements alone have been insufficient to determine the direction of groundwater flow in very low gradient areas, and other information (e.g., contaminant plume configuration, regional groundwater-flow patterns, or tracer tests) are used.

4.1.3 Geodetic Survey Issues

Prior to September 1992, geodetic surveys conducted on the Hanford Site reported reference point elevations using the National Geodetic Vertical Datum of 1929 (NGVD 29). In 1993, the Federal Geodetic Control Subcommittee affirmed the North American Vertical Datum of 1988 (NAVD 88) as the official vertical datum for surveying and mapping activities performed or financed by the federal government (Federal Register, Doc. 93-14922). NAVD 88 represents a modern and improved vertical datum for North America, and, therefore, should be a better representation of the sea-level surface (i.e., the geoid — a surface of equal gravitational potential). Since September 1992, reference point elevations for many Hanford Site wells have been resurveyed using NAVD 88, and hydraulic heads are computed using these NAVD 88 reference point elevations, if available. However, some of the wells used for water-level measurements have not been resurveyed and have reference point elevations in NGVD 29. To prepare water-table and potentiometric-surface maps, the NGVD 29 elevations are converted to NAVD 88 using a software package called Corpscon (version 5.11, U.S. Army Corps of Engineers 1997) which makes use of the VERTCON software program (version 2.0) developed by the National Geodetic Survey.

The use of the NAVD 88 vertical datum, however, does not eliminate geodetic survey errors. These errors are suspected when hydraulic heads are inconsistent with those in nearby wells over a long time period, and other sources of error are eliminated. Survey error cannot be confirmed until the well is resurveyed.

4.1.4 Measurement Techniques and Instrument Limitations

Measurement transcription is probably the most common cause of errors encountered in water-level data. These errors consist of mistakes in recording a measured water level, assigning a measured water level to the wrong well, or data entry mistakes when hand-recorded water levels are entered into a database. Surveillance and regulated-unit water-level measurements collected by WMNW are entered into a handheld computer at the time the measurement is taken. This is the only time a transcription error is possible for these measurements, because the data is downloaded directly from the handheld computer to a database. Water levels taken by PNNL or by WMNW as part of groundwater sampling are recorded on field data sheets or notebooks, and manual data entry to a database is performed later. Thus, there are two chances for transcription error with these measurements. All manually entered data is verified against the original hard copy documentation. To help make sure water levels are recorded for the proper well, almost all wells on the Hanford Site are identified with the well name written on the casing or stamped on a brass cap set in a cement pad at the well. In addition, almost all wells have an attached barcode tag that identifies the well.

The reference point/measurement point offset is another possible source of error in water-level data. Surveillance and regulated-unit water-level measurements collected by WMNW are taken from designated measuring points whose offset from the reference point is known. When the measurement is entered into the handheld computer, the reference point/measurement point offset is applied automatically to obtain the depth to water from the reference point. When measurements are taken by PNNL, or by WMNW as part of groundwater sampling, the reference point/measurement point offset is applied manually and recorded on the field data sheet or notebook. However, at some wells, the reference point is unmarked and its position has to be assumed (usually, the top of the outer casing), which can be a source of error. Historical measurements are known to be affected by the reference point/measurement point problem, because this offset was not always applied.

Water-level measuring devices have limits of accuracy and precision. As described in Section 3.1.1, measuring tapes are standardized to a calibrated tape before use, and manual measurements are used to verify the accuracy of automatic water-level recorders (Section 3.1.2). Measuring tapes are potentially subject to stretch and thermal expansion, but these factors only become important at high temperatures and measured depths in excess of about 300 meters (Garber and Koopman 1968). The largest depth to water on the Hanford Site is less than 110 meters, and temperatures are not significantly high.

4.2 Data Management

As stated in Section 4.1.4, surveillance and regulated-unit water-level measurements collected by WMNW are entered into a handheld computer at the time the measurement is taken and then downloaded to a database known as the Ground Water Monitoring System (GWMS) upon return to the office. GWMS applies the measurement point/reference point offset and stores the final depth to water from the reference point. Measurements taken by PNNL are manually entered in field data notebooks.

The Hanford Environmental Information System (HEIS) database was formerly used to permanently archive hydraulic head measurements, thus making these measurements available to project scientists, regulators, and the public. However, the hydraulic head table in this database is no longer being maintained, so project scientists, regulators and the public do not have easy access to water-level data for the Hanford Site. Currently, a project database internal to PNNL (GeoDat) is being used to store water-level data taken by the groundwater project. Water-level data is transferred electronically from GWMS into GeoDat where it is made available to project scientists for analysis. Water levels taken as part of groundwater sample collection are recorded on a field data sheet and entered into GeoDat at a later time. The use of GeoDat for the storage of water-level data is intended to be temporary, while a long-term solution to the problem of archiving water-level data is sought.

4.3 Analysis and Reporting

Water-level data are analyzed to (1) produce water-table and potentiometric-surface maps for determining groundwater flow directions, and (2) for computing groundwater flow rates. This section describes the techniques employed for this analysis, and also describes how the results of water-level monitoring are reported.

4.3.1 Water Table and Potentiometric Surface Generation

Water-table and potentiometric-surface maps are constructed by manual contouring. There are computer software packages that generate contours from discrete data points, but these packages generally do not produce acceptable results for hydraulic head data because they do not take into account the hydrogeologic framework in which the groundwater occurs. To make them work properly, much hand-editing and recalculation is necessary, which is not very cost effective.

To generate a contour map, the hydraulic head measurements to be contoured are selected and a map showing the area to be contoured along with the measurements is generated using a Geographic Information System (GIS) called ARC/INFO™ (Environmental Systems Research Institute Inc., Redlands, California). These maps are then hand contoured by a hydrogeologist. The contours are then digitized and stored in ARC/INFO, where they are made available for final map production.

Water-level measurements also are used to construct water-table change maps for the Hanford Site, which show how the water table has changed over some period of time. These maps also are prepared by hand contouring of data values. Additional maps are constructed that show the hydrogeologic units that intersect the water table, as well as the thickness of the saturated sediments above the uppermost basalt flow. To generate these maps, a digital grid of the water table is used and electronically compared to digital grids of the hydrogeologic units and the basalt surface using the EarthVision® software package (version 3.0, Dynamic Graphics Inc. 1995). This package is used to generate a grid of the water table using the measured hydraulic head values along with the digitized water-table contours. Manual editing of the grid is performed where necessary, but the addition of the digitized water-table contours provides a data point density suitable to overcome many of the problems associated with using a computer algorithm. EarthVision® is then used to calculate new grids showing the hydrogeologic units at the water table, as well as the saturated thickness of the unconfined aquifer system.

4.3.2 Groundwater Flow Rate Calculations

An annual determination of the direction and rate of groundwater movement is required for regulated units (40 CFR 265.94[b][2], WAC 173-303-645[9][e]). The rate of ground-water flow is estimated from water-level data using a form of the Darcy equation

$$v = \frac{Ki}{n_e} \tag{4.1}$$

where v = average linear groundwater velocity, m/d
K = hydraulic conductivity, m/d
i = average hydraulic gradient, m/m
n_e = effective porosity, fraction.

Representative values of hydraulic conductivity, effective porosity, and hydraulic gradient are used for each site. Values of hydraulic conductivity are taken from published hydrologic test results that best represent the uppermost part of the unconfined aquifer system. The value for effective porosity is chosen within the range of values (i.e., 0.1 to 0.3) typical for unconfined aquifer conditions. The hydraulic gradient is calculated from hydraulic head measurements in wells monitoring the facility. However, for sites where the water-table relief is low, the hydraulic gradient is uncertain and is estimated from regional hydraulic gradient considerations.

In some cases, other methods can be used to estimate groundwater-flow rate and direction, including the migration of contaminant plumes, numerical groundwater-flow modeling, or hydrochemical/isotopic groundwater age dating. For instance, contaminant plume maps are used to estimate groundwater-flow directions to confirm or provide better confidence than flow directions determined by the water-table contours. Spane and Webber (1995) estimated the groundwater flow rate in the upper basalt-confined aquifer system beneath the southern portion of the Hanford Site using carbon-14 dating of the groundwater, which provided rate estimates that were in close agreement with the hydraulic gradient method (Equation 4.1). Groundwater-flow meters have been used in the past, but are not currently used regularly.

4.3.3 Reporting

The results of surveillance and regulated-unit water-level monitoring are published annually in a groundwater monitoring report prepared by the groundwater project (e.g., Hartman 1999). The annual groundwater monitoring report (Hartman 1999) presents the major product of water-level monitoring — the water-table map for the Hanford Site. In addition, the following are also presented in the annual report:

- water-table change maps
- a water-table map for the Hanford Site and outlying areas
- an unconfined aquifer system saturated thickness map
- a map showing the hydrogeologic units at the water table
- a potentiometric surface map for locally-confined areas of the unconfined aquifer system
- a potentiometric surface map for the upper basalt-confined aquifer system
- the calculated groundwater flow velocities for each regulated unit
- a discussion of changes to the groundwater flow system during the previous year
- an appendix listing the surveillance and regulated-unit water-level measurement used to prepare these products.

This report also includes an appendix listing the surveillance and regulated-unit water-level measurements used to prepare these products.

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Appendix A

Inventory of Wells Used for Water-Level Monitoring

Appendix A

Inventory of Wells Used for Water-Level Monitoring

This appendix lists all wells used by the groundwater project for water-level monitoring on and adjacent to the Hanford Site. Onsite wells in the unconfined aquifer system are shown in Table A.1. For each well in this table, the following information is given: well name, well identification, easting and northing horizontal location coordinates in meters for the Washington Coordinate System of 1983, South Zone 1991 (WCS83S, NAD83), reference point elevation in meters above mean sea level (NAVD 88), source of the reference point elevation (i.e., NAVD 88 survey or a VERTCON conversion from an NGVD 29 survey), the hydrogeologic unit(s) being monitored by each well, the source of the hydrogeologic unit information, the regulatory class for which measurements are being taken (i.e., surveillance or regulated unit), relative monitoring zone (see Table 3.2 for a description of the relative monitoring zones and their abbreviations), and whether or not the well is used for water-table map generation. The hydrogeologic units are numbered 1 through 9 and are described in Section 2.3.1. The hydrogeologic unit "Basalt" refers to the top of the uppermost basalt flow. The following abbreviations are used in this table:

CME - Conceptual Model Extrapolation
REG - Regulated Unit
RI - Recent Interpretation
SURV - Surveillance
WI - Wurstner et al. (1995) Interpretation.

Table A.2 lists the offsite wells in the unconfined aquifer system. The well name, identification, horizontal coordinates, reference point elevation, elevation source, and the relative monitoring zone are given just as for Table A.1. In addition, the measurement frequency for each well is provided. All top of unconfined (zone TU) or upper unconfined (zone UU) offsite wells are used for water-table map generation.

Tables A.3 and A.4 list the upper basalt-confined aquifer system and lower basalt-confined aquifer wells, respectively. Just as for Table A.1, the well name, identification, horizontal coordinates, reference point elevation, and elevation source are given. In addition, the principal hydrogeologic units monitored are also listed for each well.

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
1199-37-16	A9352	594,380.2	110,861.2	111.84	Survey	1,5	CME	SURV	U	Yes
1199-38-16	A9355	594,378.0	111,052.6	112.79	Survey	1,5	CME	SURV	UU	Yes
1199-39-15	A9358	594,253.2	111,347.8	121.00	Survey	1,5	CME	SURV	UU	Yes
1199-39-16A	A9359	594,391.6	111,170.6	113.60	Survey	1,5	CME	SURV	U	Yes
1199-39-16C	A9361	594,291.7	111,252.8	118.95	Survey	1,5	CME	SURV	U	Yes
1199-39-16E	A9363	594,311.8	111,168.3	122.26	Survey	1,5	CME	SURV	UU	Yes
1199-41-15	A9371	594,163.2	111,757.8	122.53	Survey	1,5,6	CME	SURV	TU	Yes
199-B3-1	A4552	565,561.5	145,342.1	134.88	Survey	1,5	CME	SURV	TU	Yes
199-B3-46	A4553	565,899.6	145,369.0	135.63	Survey	1,5	RI	SURV	TU	Yes
199-B4-1	A4555	565,289.8	144,791.5	141.60	Survey	1,5	CME	SURV	TU	Yes
199-B4-9	A4560	565,395.6	144,563.9	144.72	Survey	1	RI	SURV	TU	Yes
199-B5-1	A4561	564,878.1	144,764.9	139.89	Survey	1,5	CME	SURV	UU	Yes
199-B8-6	A4563	564,498.8	144,157.8	145.93	Survey	1	CME	SURV	TU	Yes
199-D2-6	A4568	573,000.2	151,119.9	144.09	VERTCON	1	WI	REG	TU	Yes
199-D3-2	B8074	572,454.0	151,165.7	143.79	Survey	1,5	CME	REG	TU	Yes
199-D4-13	B8071	572,665.9	151,424.5	143.83	Survey	1	CME	REG	TU	Yes
199-D4-14	B8072	572,839.8	151,641.6	144.34	Survey	1,5	CME	REG	TU	Yes
199-D4-15	B8073	572,936.6	151,424.9	144.57	Survey	1	CME	REG	TU	Yes
199-D5-13	A4570	573,535.5	151,955.2	144.71	Survey	1,6	CME	REG	TU	Yes
199-D5-14	A4571	573,789.9	151,788.2	144.83	VERTCON	1	CME	REG	TU	Yes
199-D5-16	A4573	573,917.5	151,652.5	145.20	VERTCON	1	CME	REG	TU	Yes
199-D5-17	A4574	573,730.5	151,322.8	144.16	VERTCON	1	CME	REG	TU	Yes
199-D5-19	A4576	573,849.1	151,243.2	142.73	VERTCON	1,6	WI	REG	TU	Yes
199-D5-20	A4577	573,240.0	152,030.2	143.74	VERTCON	5,6	CME	REG	TU	Yes
199-D8-4	A4579	573,447.2	152,090.2	143.87	Survey	5,6	CME	REG	TU	Yes
199-D8-5	A4580	573,537.1	152,243.5	138.92	Survey	1,5,6	CME	REG	TU	Yes
199-D8-53	A4581	573,889.9	152,452.3	133.96	VERTCON	5	WI	REG	TU	Yes
199-D8-54B	A4583	573,768.2	152,398.7	135.94	VERTCON	6	CME	REG	CR	No
199-F1-2	A4586	580,011.0	148,805.3	122.33	Survey	1	CME	SURV	TU	Yes
199-F5-1	A4587	581,250.1	147,736.9	124.57	Survey	1,6	CME	SURV	UU	Yes
199-F5-4	A4590	580,583.2	147,533.7	126.64	Survey	1,6	CME	SURV	TU	Yes
199-F5-6	A4600	580,901.7	148,042.0	127.04	Survey	1,6	CME	SURV	U	Yes
199-F7-1	A4603	579,687.2	147,022.4	119.35	Survey	1,4	RI	SURV	TU	Yes
199-F7-2	A4604	580,060.0	147,770.4	121.28	Survey	1	CME	SURV	TU	Yes
199-F8-4	A4609	580,958.5	147,123.5	126.28	Survey	1	CME	SURV	TU	Yes
199-H3-2A	A4611	577,624.6	152,750.1	128.54	Survey	1,6	CME	REG	TU	No
199-H3-2B	A4612	577,628.3	152,757.2	128.72	Survey	6	CME	REG	UU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
199-H4-10	A4614	577,827.2	153,155.8	124.46	Survey	1	WI	REG	TU	Yes
199-H4-12A	A4616	578,009.2	152,912.7	127.22	Survey	1,5	CME	REG	TU	No
199-H4-12B	A4617	578,004.4	152,918.5	127.22	Survey	5	CME	REG	UU	Yes
199-H4-12C	A4618	578,011.8	152,919.8	127.23	Survey	6	WI	REG	DU	No
199-H4-13	A4619	578,219.3	152,595.3	128.65	Survey	1	CME	REG	TU	Yes
199-H4-15B	A4622	577,899.6	153,059.5	125.21	Survey	1,5	CME	REG	UU	Yes
199-H4-15CP	A9496	577,907.7	153,060.0	125.26	Survey	Basalt	WI	REG	TB	No
199-H4-15CQ	A4623	577,907.7	153,060.0	125.32	Survey	8	WI	REG	CR	No
199-H4-15CR	A4624	577,907.7	153,060.0	125.35	Survey	6	WI	REG	DU	No
199-H4-15CS	A4625	577,907.7	153,060.0	125.37	Survey	5,6	WI	REG	DU	No
199-H4-16	A4626	577,981.9	152,591.6	130.49	Survey	1,5,6	CME	REG	TU	Yes
199-H4-17	A4627	577,779.2	153,037.6	128.92	Survey	1	CME	REG	TU	Yes
199-H4-18	A4628	578,018.3	152,756.5	129.75	Survey	1	CME	REG	TU	Yes
199-H4-3	A4629	577,940.5	152,858.5	129.30	Survey	1,5	WI	REG	TU	Yes
199-H4-4	A4630	578,060.9	152,854.0	127.29	Survey	1	CME	REG	TU	Yes
199-H4-45	A4631	578,156.4	152,433.4	128.01	Survey	1	CME	REG	TU	Yes
199-H4-46	A4632	577,883.9	152,439.9	130.31	Survey	1	WI	REG	TU	Yes
199-H4-47	A4633	577,891.2	152,553.3	130.53	Survey	1,6	WI	REG	TU	Yes
199-H4-48	A4634	577,792.7	152,620.2	130.87	Survey	1,6	CME	REG	TU	Yes
199-H4-49	A4635	577,713.8	152,445.2	130.51	Survey	1	CME	REG	TU	Yes
199-H4-5	A4636	577,944.9	152,939.8	128.06	Survey	1	CME	REG	TU	Yes
199-H4-6	A4637	577,585.3	152,888.4	129.07	Survey	1,6	CME	REG	TU	Yes
199-H4-8	A4639	577,860.7	152,921.7	129.21	Survey	1	CME	REG	TU	Yes
199-H4-9	A4640	577,923.2	152,893.9	128.62	Survey	1	CME	REG	TU	Yes
199-H5-1A	A4641	577,650.1	152,257.7	129.08	Survey	1	WI	REG	TU	Yes
199-H6-1	A4642	578,236.6	152,247.6	128.46	Survey	1	CME	REG	TU	Yes
199-K-19	A4648	569,458.5	147,386.6	129.69	Survey	5	CME	SURV	TU	Yes
199-K-20	A4649	569,520.5	147,687.2	129.64	Survey	5	CME	SURV	TU	Yes
199-K-21	A4650	569,769.9	147,932.1	129.56	Survey	5	CME	SURV	TU	Yes
199-K-27	A4653	569,156.0	146,763.8	143.27	Survey	5	CME	SURV	TU	Yes
199-K-34	A4660	568,605.8	146,501.9	143.73	VERTCON	5	CME	SURV	TU	Yes
199-K-35	A4661	568,832.3	146,110.7	151.80	VERTCON	5	WI	SURV	TU	Yes
199-K-36	A4662	569,373.8	146,390.7	151.65	VERTCON	5	CME	SURV	TU	Yes
199-K-37	A4663	570,216.2	148,226.5	135.68	Survey	5	CME	SURV	TU	Yes
199-N-14	A4664	571,713.1	150,243.4	139.22	Survey	5	WI	REG	TU	Yes
199-N-16	A4665	571,281.4	149,441.8	140.39	Survey	5	WI	REG	TU	Yes
199-N-17	A4666	571,276.8	149,713.4	141.76	Survey	5	CME	REG	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
199-N-2	A4669	571,476.2	149,859.4	141.16	Survey	5	CME	REG	TU	Yes
199-N-25	A4674	571,050.9	149,484.9	130.95	Survey	5	CME	REG	TU	Yes
199-N-26	A4675	571,056.9	149,410.0	140.09	Survey	5	CME	REG	TU	Yes
199-N-27	A4676	572,052.6	149,659.8	138.06	Survey	5	CME	REG	TU	Yes
199-N-28	A4677	571,955.3	149,476.7	142.68	Survey	5	CME	REG	TU	Yes
199-N-3	A4679	571,317.4	149,794.6	141.05	Survey	5	CME	REG	TU	Yes
199-N-31	A4680	571,810.6	149,682.8	142.19	Survey	5	CME	REG	TU	Yes
199-N-32	A4681	571,907.6	149,708.5	142.02	Survey	5	CME	REG	TU	Yes
199-N-33	A4682	571,752.1	149,729.9	141.35	Survey	5	CME	REG	TU	Yes
199-N-34	A4683	571,737.4	149,653.9	141.28	Survey	5	CME	REG	TU	Yes
199-N-41	A4689	572,182.2	149,965.3	140.66	Survey	5	CME	REG	TU	Yes
199-N-43	A5831	572,366.2	150,139.9	138.05	Survey	5	CME	REG	TU	Yes
199-N-49	A4692	571,991.7	150,050.3	138.57	Survey	5	CME	REG	TU	Yes
199-N-50	A4693	572,090.9	150,298.8	142.42	Survey	5	WI	REG	TU	Yes
199-N-51	A4694	571,796.1	150,497.0	142.06	Survey	1,5	CME	REG	TU	Yes
199-N-52	A4695	572,302.9	149,466.2	142.51	Survey	5	CME	REG	TU	Yes
199-N-56	A4699	571,375.9	149,703.5	140.80	Survey	5	CME	REG	TU	Yes
199-N-57	A4700	571,413.2	149,542.1	140.70	Survey	5	CME	REG	TU	Yes
199-N-59	A4702	571,258.2	149,150.5	141.25	Survey	5	CME	REG	TU	Yes
199-N-62	A4706	571,725.6	149,483.1	142.49	Survey	5	CME	REG	TU	Yes
199-N-66	A4710	571,636.9	149,684.1	142.99	Survey	5	CME	REG	TU	Yes
199-N-67	A4711	571,494.2	149,798.9	140.92	Survey	5	CME	REG	TU	Yes
199-N-71	A4714	571,588.8	148,982.2	142.15	Survey	5	CME	REG	TU	Yes
199-N-72	A4715	571,302.2	149,249.7	140.92	Survey	5	CME	REG	TU	Yes
199-N-73	A4716	571,292.0	149,169.0	142.23	Survey	5	CME	REG	TU	Yes
199-N-74	A4717	571,941.9	149,156.1	140.51	Survey	5	CME	REG	TU	Yes
199-N-76	A4719	571,560.1	150,122.1	138.86	VERTCON	5	CME	REG	TU	Yes
199-N-77	A5442	571,309.8	149,243.0	141.06	Survey	5	WI	REG	UU	No
199-N-81	A5443	572,019.2	149,866.1	142.07	Survey	5	CME	REG	TU	Yes
199-N-8P	A5816	571,326.9	149,924.2	124.68	Survey	6	CME	REG	DU	No
199-N-92A	A9878	571,647.4	150,383.5	122.08	Survey	5	CME	REG	TU	Yes
199-N-96A	A9882	571,213.5	149,800.8	123.66	Survey	5	CME	REG	TU	Yes
199-N-99A	A9910	571,476.7	150,151.4	121.65	Survey	5	CME	REG	TU	Yes
299-E13-10	A4724	573,194.8	134,252.5	226.31	Survey	5	RI	SURV	TU	Yes
299-E13-14	A4726	573,087.5	134,474.1	228.24	Survey	1,5	RI	SURV	TU	Yes
299-E17-1	A4728	574,977.1	135,386.2	220.31	Survey	5	RI	SURV	TU	Yes
299-E17-12	A4730	574,905.4	135,125.9	221.09	Survey	5	RI	SURV	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
299-E17-14	A4732	575,140.6	135,333.7	221.23	Survey	5	RI	REG	TU	Yes
299-E17-18	A4736	575,112.4	135,123.6	220.76	Survey	5	RI	REG	TU	Yes
299-E17-19	A4737	575,017.2	135,414.9	220.36	Survey	5	RI	REG	TU	Yes
299-E18-1	A4743	573,296.6	135,200.2	220.65	Survey	1	RI	SURV	TU	Yes
299-E18-2	A4744	573,392.2	135,291.0	220.95	Survey	1	CME	SURV	TU	Yes
299-E23-1	A4747	574,043.4	136,016.6	218.38	Survey	1	CME	SURV	UU	Yes
299-E24-16	A4751	575,017.6	135,464.4	220.02	Survey	5	RI	SURV	TU	Yes
299-E24-18	A4753	574,647.1	135,469.8	220.35	Survey	1,5	RI	REG	TU	Yes
299-E24-19	A4754	575,317.0	136,003.5	212.51	Survey	5	RI	REG	TU	Yes
299-E24-20	A4756	575,251.1	136,049.4	211.16	VERTCON	5	RI	REG	TU	Yes
299-E24-8	A4758	574,546.8	136,271.8	210.90	Survey	1,7,8,9	RI	SURV	U	Yes
299-E25-11	A4761	575,835.0	135,558.6	208.74	Survey	1	RI	SURV	U	No
299-E25-12	A6028	575,978.7	135,491.0	208.63	Survey	1	RI	REG	U	Yes
299-E25-19	A4765	575,852.3	135,659.0	207.50	Survey	1	CME	SURV	TU	Yes
299-E25-2	A4766	575,513.8	136,061.9	206.95	Survey	1,9	CME	REG	UU	Yes
299-E25-26	A4771	575,907.5	135,912.9	204.85	Survey	1	CME	REG	TU	Yes
299-E25-28	A4773	576,011.8	136,111.7	203.00	Survey	9	RI	REG	DU	No
299-E25-31	A4778	575,948.0	135,772.3	206.65	Survey	5	RI	REG	TU	Yes
299-E25-32P	A4779	576,382.4	136,044.3	205.29	VERTCON	9	RI	REG	TU	Yes
299-E25-34	A4782	576,019.0	136,100.0	203.12	Survey	1	CME	REG	TU	Yes
299-E25-35	A4783	575,708.3	135,864.7	206.64	Survey	1	CME	REG	TU	Yes
299-E25-36	A4784	575,403.6	135,566.4	216.74	Survey	1	CME	REG	TU	Yes
299-E25-40	A4789	575,464.7	136,212.3	204.00	Survey	1	CME	REG	TU	Yes
299-E25-41	A4790	575,466.1	136,145.9	205.69	Survey	1	CME	REG	TU	Yes
299-E25-42	A4791	575,622.8	135,887.6	209.33	VERTCON	1	CME	SURV	TU	Yes
299-E25-44	A5448	576,109.9	135,656.6	206.84	Survey	1	CME	REG	TU	Yes
299-E25-46	A4793	575,359.7	135,963.5	212.80	Survey	1	CME	REG	TU	Yes
299-E25-48	A4795	575,623.9	135,815.7	208.98	Survey	1	CME	REG	TU	Yes
299-E26-10	A4799	575,589.0	137,023.5	184.42	Survey	1,Basalt	RI	REG	TU	Yes
299-E26-11	A4800	576,180.0	137,134.6	183.88	Survey	Basalt	RI	REG	UU	Yes
299-E26-12	A4801	576,197.7	136,383.2	193.31	VERTCON	1,9	CME	REG	TU	Yes
299-E26-13	A4802	576,199.3	136,528.6	185.47	VERTCON	1,9	CME	REG	TU	Yes
299-E26-2	A4803	575,973.1	136,408.8	194.79	Survey	1,9	CME	SURV	UU	Yes
299-E26-4	A4804	575,734.0	136,360.9	198.58	Survey	1,9	CME	SURV	UU	Yes
299-E26-9	A4806	575,576.1	137,133.1	184.85	Survey	1	RI	REG	TU	Yes
299-E27-10	A4808	575,100.3	137,052.5	191.43	Survey	1	CME	REG	TU	Yes
299-E27-11	A4809	574,652.9	137,062.7	197.16	Survey	1	CME	REG	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
299-E27-12	A4810	575,054.1	136,583.5	202.55	Survey	1,9	CME	REG	TU	Yes
299-E27-13	A4811	575,064.9	136,489.2	204.92	Survey	1,9	CME	REG	TU	Yes
299-E27-14	A4812	575,217.3	136,498.2	201.75	Survey	1,9	CME	REG	TU	Yes
299-E27-15	A4813	575,095.3	136,630.4	200.02	Survey	1	CME	REG	TU	Yes
299-E27-16	A4814	574,179.2	137,164.9	199.86	Survey	1	RI	REG	TU	Yes
299-E27-17	A4815	574,547.3	137,122.0	194.48	Survey	1	RI	REG	TU	Yes
299-E27-18	A6674	574,299.6	137,119.3	199.18	Survey	1	RI	REG	TU	Yes
299-E27-19	A6675	574,355.1	137,103.6	199.40	VERTCON	1	CME	REG	TU	Yes
299-E27-7	A4816	575,220.6	136,619.4	194.54	Survey	9,Basalt	CME	REG	UU	Yes
299-E27-8	A4817	574,759.1	137,044.2	195.50	Survey	1	CME	REG	TU	Yes
299-E27-9	A4818	574,917.6	137,040.9	192.87	Survey	1	CME	REG	TU	Yes
299-E28-14	A6792	573,848.3	136,551.3	212.76	Survey	9	CME	SURV	DU	No
299-E28-17	A4820	573,461.2	136,331.7	216.70	Survey	1,9	CME	SURV	UU	Yes
299-E28-26	A4822	572,941.6	137,024.0	210.57	Survey	9	RI	REG	TU	Yes
299-E28-27	A4823	573,226.8	137,070.1	208.47	Survey	1,9	WI	REG	TU	Yes
299-E28-28	A4824	572,804.4	137,108.3	210.35	Survey	1	CME	REG	TU	Yes
299-E28-4	A4825	573,998.8	136,513.2	211.78	Survey	1,9	CME	SURV	UU	Yes
299-E28-8	A6788	573,698.1	137,074.3	204.83	VERTCON	1,Basalt	CME	REG	TU	Yes
299-E28-9	A4828	573,096.5	136,587.2	214.63	Survey	1,9	CME	SURV	U	Yes
299-E32-10	A5432	572,951.1	137,741.7	195.45	Survey	1	RI	REG	TU	Yes
299-E32-2	A4830	572,648.0	137,467.5	205.33	Survey	1	CME	REG	TU	Yes
299-E32-3	A4831	572,600.6	137,384.0	207.29	Survey	1	CME	REG	TU	Yes
299-E32-4	A4832	572,603.7	137,187.2	210.15	Survey	1	WI	REG	TU	Yes
299-E32-5	A4833	572,599.7	137,285.1	209.01	Survey	1	CME	REG	TU	Yes
299-E32-6	A4834	572,600.4	137,515.1	204.45	Survey	1	CME	REG	TU	Yes
299-E32-7	A4835	572,600.4	137,647.1	201.70	Survey	1	CME	REG	TU	Yes
299-E32-8	A4836	572,663.4	137,741.5	197.79	Survey	1	CME	REG	TU	Yes
299-E32-9	A4837	572,795.1	134,741.7	197.10	VERTCON	1,Basalt	CME	REG	TU	Yes
299-E33-13	A4840	573,706.5	137,584.4	192.55	Survey	1,Basalt	CME	REG	TU	Yes
299-E33-14	A4841	573,985.6	137,567.2	190.63	Survey	1,Basalt	CME	REG	TU	Yes
299-E33-15	A4842	573,810.3	137,540.7	192.22	Survey	1	RI	REG	TU	Yes
299-E33-16	A6855	573,791.7	137,465.3	195.70	Survey	1	RI	REG	TU	Yes
299-E33-17	A4843	573,878.5	137,467.2	193.56	Survey	1	RI	REG	TU	Yes
299-E33-18	A4844	573,779.2	137,386.1	199.71	Survey	1	RI	REG	TU	Yes
299-E33-20	A4847	573,847.6	137,397.9	199.16	Survey	1	RI	REG	TU	Yes
299-E33-21	A4848	573,474.4	137,293.1	204.74	Survey	1	RI	REG	TU	Yes
299-E33-25	A6858	573,365.2	137,681.6	193.34	Survey	1	RI	REG	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
299-E33-26	A4850	573,333.3	137,681.5	193.88	Survey	1	RI	REG	TU	Yes
299-E33-28	A4852	573,226.4	137,375.0	203.54	Survey	1	WI	REG	TU	Yes
299-E33-29	A4853	573,227.9	137,231.2	206.43	Survey	9	RI	REG	TU	Yes
299-E33-30	A4855	572,923.8	137,467.8	203.39	Survey	1	WI	REG	TU	Yes
299-E33-31	A4856	573,525.0	137,491.4	198.36	Survey	1	RI	REG	TU	Yes
299-E33-32	A4857	573,524.8	137,354.0	202.18	Survey	1	RI	REG	TU	Yes
299-E33-33	A4858	574,080.1	137,301.9	196.21	Survey	1	RI	REG	TU	Yes
299-E33-34	A4859	573,104.5	137,740.4	194.13	Survey	1,Basalt	RI	REG	TU	Yes
299-E33-35	A4860	573,220.8	137,605.1	197.07	Survey	1	RI	REG	TU	Yes
299-E33-36	A4861	574,068.5	137,240.0	198.19	Survey	1	RI	REG	TU	Yes
299-E33-37	A4862	574,091.5	137,185.4	200.12	Survey	1	RI	REG	TU	Yes
299-E33-38	A4863	573,591.2	137,594.5	193.63	Survey	1,Basalt	RI	REG	TU	Yes
299-E33-39	A4864	573,843.5	137,637.4	191.01	Survey	1,Basalt	RI	REG	TU	Yes
299-E33-41	A4867	573,707.2	137,369.9	200.64	Survey	1	RI	REG	TU	Yes
299-E33-42	A4868	573,521.0	137,424.4	200.43	Survey	1	RI	REG	TU	Yes
299-E33-43	A4869	573,523.2	137,325.4	202.99	Survey	1	RI	REG	TU	Yes
299-E33-44	B8554	573,706.4	137,469.2	196.77	Survey	1,Basalt	RI	REG	TU	Yes
299-E33-5	A4870	573,574.2	137,606.4	194.47	Survey	1	RI	REG	TU	Yes
299-E33-7	A4871	573,574.0	137,696.0	192.38	Survey	1,Basalt	CME	REG	TU	Yes
299-E33-8	A4872	573,475.3	137,447.9	199.43	Survey	1	RI	REG	TU	Yes
299-E34-10	A4875	574,284.4	137,224.6	196.02	Survey	1	CME	REG	TU	Yes
299-E34-11	A4876	574,176.2	137,581.8	189.36	VERTCON	1,Basalt	RI	REG	TU	Yes
299-E34-12	A5433	574,411.0	137,168.5	195.73	Survey	1	RI	REG	TU	Yes
299-E34-2	A4877	574,634.8	137,220.7	193.35	Survey	1	WI	REG	TU	Yes
299-E34-3	A4878	575,110.3	137,301.4	187.48	Survey	1	WI	REG	TU	Yes
299-E34-5	A4880	574,643.8	137,743.3	181.17	Survey	1,Basalt	CME	REG	TU	Yes
299-E34-7	A4882	575,274.2	137,357.7	185.26	Survey	1	CME	REG	TU	Yes
299-E34-8	A4883	574,206.4	137,249.6	196.33	Survey	1	CME	REG	TU	Yes
299-E34-9	A4884	574,186.0	137,429.8	192.64	Survey	1	RI	REG	TU	Yes
299-E35-2	A4886	575,576.1	137,255.1	184.61	Survey	1,Basalt	RI	REG	TU	Yes
299-W10-10	A4887	566,751.3	136,805.9	206.87	Survey	5	CME	REG	TU	Yes
299-W10-11	A4888	566,755.0	136,802.2	206.85	Survey	5	CME	REG	TU	Yes
299-W10-12	A4889	566,755.6	136,797.5	206.77	Survey	5	CME	REG	TU	Yes
299-W10-13	A4890	566,027.4	136,606.8	214.17	Survey	5	WI	REG	TU	Yes
299-W10-14	A4891	566,017.2	136,608.9	214.29	Survey	5	WI	REG	DU	No
299-W10-17	A4894	566,775.4	136,491.2	205.50	Survey	5	CME	REG	TU	Yes
299-W10-18	A4895	566,846.9	136,396.3	205.52	Survey	5	CME	REG	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
299-W10-19	A5438	566,346.2	137,037.1	209.24	VERTCON	5	CME	REG	TU	Yes
299-W10-20	A5439	566,249.7	136,866.6	210.60	Survey	5	CME	REG	TU	Yes
299-W10-21	A5440	566,584.0	137,154.7	206.49	Survey	5	CME	REG	TU	Yes
299-W10-22	A9890	566,832.6	136,883.1	208.95	Survey	5	CME	REG	TU	Yes
299-W10-8	A4899	566,848.8	136,811.2	208.38	Survey	5	CME	REG	TU	Yes
299-W11-10	A4901	568,147.5	136,610.0	223.19	Survey	5	CME	SURV	TU	Yes
299-W11-12	A4902	566,927.1	136,604.0	208.20	VERTCON	5	CME	REG	TU	Yes
299-W11-23	A4905	566,905.0	136,801.1	210.78	Survey	5	CME	REG	TU	Yes
299-W11-27	A4907	566,885.0	136,796.6	209.94	VERTCON	5	CME	REG	TU	Yes
299-W11-28	A4908	566,934.9	136,743.7	212.44	VERTCON	5	CME	REG	TU	Yes
299-W11-31	A5472	567,221.6	137,235.3	216.52	VERTCON	5	CME	REG	TU	Yes
299-W11-6	A4909	567,481.6	136,492.8	219.77	Survey	5	CME	SURV	UU	Yes
299-W11-7	A4910	567,260.9	136,675.3	217.11	Survey	5	CME	SURV	U	Yes
299-W11-9	A4911	567,781.0	136,667.3	221.38	Survey	5	CME	SURV	UU	Yes
299-W12-1	A4912	568,331.2	137,206.1	222.44	Survey	5	CME	SURV	TU	Yes
299-W14-12	A4914	566,905.7	136,284.2	205.44	VERTCON	5	CME	REG	TU	Yes
299-W15-13	A4918	566,845.5	136,369.5	205.32	VERTCON	5	CME	REG	TU	Yes
299-W15-15	A4919	566,088.8	135,751.5	213.84	Survey	5	WI	REG	TU	Yes
299-W15-16	A4920	566,307.0	135,733.6	209.85	Survey	5	WI	REG	TU	Yes
299-W15-17	A4921	566,306.9	135,719.0	209.78	Survey	5	CME	REG	DU	No
299-W15-18	A4922	566,308.7	135,561.8	210.10	Survey	5	WI	REG	TU	Yes
299-W15-2	A5466	566,093.8	136,336.2	212.41	Survey	5	CME	SURV	TU	Yes
299-W15-22	A4925	566,683.0	136,110.9	205.48	Survey	5	CME	REG	TU	Yes
299-W15-31A	B2471	566,377.1	135,856.1	208.48	Survey	5	CME	SURV	TU	Yes
299-W15-38	B2754	566,812.9	135,672.9	203.69	Survey	5	CME	SURV	TU	Yes
299-W15-39	B2755	566,819.2	135,553.0	202.13	Survey	5	CME	SURV	TU	Yes
299-W15-4	A4929	566,826.3	136,027.7	203.17	Survey	5	CME	SURV	TU	Yes
299-W15-7	A5476	566,675.9	135,920.2	204.25	Survey	5	CME	SURV	U	Yes
299-W18-21	A4933	566,097.7	134,978.7	204.90	Survey	5	WI	REG	TU	Yes
299-W18-22	A4934	566,088.6	134,990.2	204.86	Survey	5,8	WI	REG	DU	No
299-W18-23	A4935	566,084.5	135,342.4	213.48	Survey	5	WI	REG	TU	Yes
299-W18-24	A4936	566,370.8	135,346.3	209.70	Survey	5	WI	REG	TU	Yes
299-W18-25	A4937	566,721.5	134,978.2	204.08	VERTCON	5	CME	REG	TU	Yes
299-W18-26	A4938	566,091.3	135,491.7	214.12	Survey	5	CME	REG	TU	Yes
299-W18-27	A4939	566,090.2	135,226.5	211.35	Survey	5	CME	REG	TU	Yes
299-W18-28	A4940	566,092.6	135,106.8	208.22	Survey	5	CME	REG	TU	Yes
299-W18-30	A4942	566,870.8	135,193.6	206.12	Survey	5	CME	REG	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
299-W18-31	A4943	566,721.5	135,075.2	203.47	Survey	5	CME	REG	TU	Yes
299-W18-32	A5441	566,515.6	134,975.6	207.28	Survey	5	CME	REG	TU	Yes
299-W18-33	A5450	566,723.3	134,811.1	204.91	Survey	5	CME	REG	TU	Yes
299-W19-14	A4946	567,268.0	134,831.1	212.39	Survey	5	CME	SURV	TU	Yes
299-W19-15	A4947	567,254.3	134,975.8	212.41	Survey	5	CME	SURV	UU	Yes
299-W19-20	A4949	567,874.0	134,901.1	211.72	Survey	5	CME	SURV	TU	Yes
299-W19-28	A4954	567,589.8	134,991.2	215.39	Survey	5	CME	SURV	TU	Yes
299-W19-31	A4956	566,897.0	135,127.5	206.56	VERTCON	5	CME	REG	TU	Yes
299-W19-32	A4957	566,896.6	135,009.3	206.78	VERTCON	5	CME	REG	TU	Yes
299-W22-20	A7843	567,593.1	133,879.2	207.09	Survey	5	CME	SURV	U	Yes
299-W22-24P	A9568	567,648.2	134,410.9	212.24	VERTCON	9	RI	SURV	DU	No
299-W22-24Q	A9569	567,648.2	134,410.9	212.24	VERTCON	9	WI	SURV	DU	No
299-W22-24R	A9570	567,648.2	134,410.9	212.24	VERTCON	8	RI	SURV	DU	No
299-W22-24S	A9571	567,648.2	134,410.9	212.24	VERTCON	5	RI	SURV	DU	No
299-W22-24T	A9572	567,648.2	134,410.9	212.24	VERTCON	5	RI	SURV	DU	No
299-W22-39	A4970	566,903.9	134,213.7	204.75	VERTCON	5	CME	REG	TU	Yes
299-W22-40	A4971	567,634.6	134,510.0	212.14	VERTCON	5	CME	REG	TU	Yes
299-W22-41	A4972	567,637.1	134,479.5	211.99	VERTCON	5	RI	REG	TU	Yes
299-W22-42	A4973	567,623.2	134,452.2	211.81	VERTCON	5	RI	REG	TU	Yes
299-W22-43	A4974	567,532.5	134,539.2	211.87	VERTCON	5	CME	REG	TU	Yes
299-W22-44	A4975	566,956.0	134,484.4	207.76	VERTCON	5	CME	REG	TU	Yes
299-W22-45	A4976	566,945.2	134,292.5	204.13	VERTCON	5	CME	REG	TU	Yes
299-W22-46	A4977	566,903.9	134,127.8	205.64	VERTCON	5	CME	REG	TU	Yes
299-W22-79	B8552	567,629.5	134,464.8	211.74	Survey	5	RI	REG	UU	Yes
299-W23-11	A4980	566,512.3	134,299.0	203.55	Survey	5	CME	SURV	UU	Yes
299-W23-13	A4982	566,712.8	134,445.9	204.16	VERTCON	5	CME	REG	TU	Yes
299-W23-14	A4983	566,708.7	134,290.2	203.45	VERTCON	5	CME	REG	TU	Yes
299-W23-15	A4984	566,794.0	134,127.2	200.84	VERTCON	5	CME	REG	TU	Yes
299-W26-10	A4992	566,683.2	133,499.1	205.55	VERTCON	5	CME	REG	TU	Yes
299-W26-12	A5409	566,901.0	133,689.9	207.02	VERTCON	5	CME	REG	TU	Yes
299-W26-7	A5446	566,325.5	133,242.4	199.79	VERTCON	5	CME	REG	TU	Yes
299-W26-8	A4994	566,645.7	133,663.5	204.20	Survey	5	CME	REG	TU	Yes
299-W26-9	A4995	566,491.8	133,228.8	200.50	Survey	5	CME	REG	TU	Yes
299-W6-10	A5435	567,413.3	137,453.1	218.23	VERTCON	5	CME	REG	TU	Yes
299-W6-11	A5436	567,162.5	137,634.8	215.25	Survey	5	CME	REG	TU	Yes
299-W6-12	A5437	566,915.5	137,635.2	212.09	Survey	5	CME	REG	TU	Yes
299-W6-2	A4997	566,938.4	137,351.0	212.16	Survey	5	WI	REG	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
299-W6-3	A4998	567,118.2	137,299.1	214.37	VERTCON	5,8	CME	REG	DU	No
299-W6-4	A4999	567,132.3	137,290.5	214.81	VERTCON	5	CME	REG	TU	Yes
299-W6-5	A5000	567,493.3	137,638.6	213.98	VERTCON	5	CME	REG	DU	No
299-W6-6	A5001	567,318.7	137,638.7	217.47	VERTCON	9	CME	REG	DU	No
299-W6-7	A5002	567,311.3	137,638.8	217.56	VERTCON	5	CME	REG	TU	Yes
299-W6-8	A5003	567,028.8	137,638.8	212.82	VERTCON	5	CME	REG	TU	Yes
299-W6-9	A5434	567,031.6	137,363.1	213.24	VERTCON	5	CME	REG	TU	Yes
299-W7-1	A5004	565,932.0	137,647.1	211.63	Survey	5	WI	REG	TU	Yes
299-W7-10	A5005	566,858.2	137,457.5	211.31	Survey	5	CME	REG	TU	Yes
299-W7-11	A5006	566,186.2	137,636.0	208.77	VERTCON	5	CME	REG	TU	Yes
299-W7-12	A5007	566,040.8	137,636.3	210.75	VERTCON	5	CME	REG	TU	Yes
299-W7-3	A5009	566,292.0	137,638.6	207.19	Survey	9	RI	REG	DU	No
299-W7-4	A5010	566,408.8	137,308.2	205.83	Survey	5	WI	REG	TU	Yes
299-W7-5	A5011	566,476.0	137,635.7	206.23	Survey	5	WI	REG	TU	Yes
299-W7-6	A5012	566,658.1	137,636.3	207.94	Survey	5	WI	REG	TU	Yes
299-W7-7	A5013	566,566.7	137,636.1	206.82	Survey	5	CME	REG	TU	Yes
299-W7-8	A5014	566,761.4	137,636.7	210.60	Survey	5	CME	REG	TU	Yes
299-W7-9	A5015	565,844.4	137,646.4	212.05	Survey	5	CME	REG	TU	Yes
299-W8-1	A5016	565,749.4	137,646.6	214.86	Survey	5	WI	REG	TU	Yes
299-W9-1	A5017	565,657.7	137,023.8	225.96	Survey	5	CME	REG	TU	Yes
3099-42-16	A9385	594,463.2	112,007.6	125.41	Survey	1,5,6,7	CME	SURV	U	Yes
3099-47-18B	A5062	594,896.8	113,704.6	115.39	Survey	1,6	RI	SURV	UU	Yes
399-1-1	A5018	594,360.0	116,588.8	115.84	Survey	5	CME	REG	TU	Yes
399-1-10A	A5411	594,346.6	116,734.0	114.89	Survey	5	CME	REG	TU	Yes
399-1-11	A5020	594,109.8	116,660.2	116.16	Survey	5	CME	REG	TU	Yes
399-1-12	A5021	594,040.3	116,548.5	118.20	Survey	5	CME	REG	UU	Yes
399-1-13A	A5412	593,910.4	116,557.3	119.47	Survey	5	CME	REG	TU	Yes
399-1-14A	A5413	593,901.1	116,778.2	117.82	Survey	5	CME	REG	TU	Yes
399-1-15	A5024	593,988.3	116,964.2	116.71	Survey	1,5	CME	REG	TU	Yes
399-1-16A	A5025	594,318.1	116,414.1	117.30	Survey	1,5	CME	REG	TU	Yes
399-1-16B	A5026	594,324.7	116,411.6	117.19	Survey	5	CME	REG	DU	No
399-1-17A	A5028	594,112.9	116,413.8	116.07	Survey	5	CME	REG	TU	Yes
399-1-17B	A5029	594,104.8	116,417.7	116.19	Survey	5	CME	REG	DU	No
399-1-17C	A5030	594,104.7	116,409.2	116.26	Survey	8,Basalt	WI	REG	CR	No
399-1-18A	A5031	593,870.6	117,301.6	120.14	Survey	1,5	CME	REG	TU	Yes
399-1-18B	A5032	593,866.1	117,297.2	119.87	Survey	5	CME	REG	DU	No
399-1-18C	A5033	593,872.3	117,294.6	119.30	Survey	9	WI	REG	DU	No

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
399-1-19	A5034	594,085.1	116,465.1	115.21	Survey	5	CME	REG	U	No
399-1-3	A5036	594,254.2	116,334.9	118.29	Survey	1,5	CME	REG	TU	No
399-1-4	A5037	594,020.6	116,699.6	117.03	Survey	5	CME	REG	UU	Yes
399-1-5	A5038	594,111.7	116,552.1	116.79	Survey	5	CME	REG	TU	Yes
399-1-6	A5039	594,142.5	116,900.1	114.96	Survey	5	CME	REG	TU	Yes
399-1-7	A5040	594,260.1	116,335.1	118.56	Survey	1,5	CME	REG	TU	Yes
399-1-8	A5041	594,257.8	116,329.6	118.34	Survey	5	CME	REG	DU	No
399-1-9	A5042	594,254.0	116,330.4	118.31	Survey	8,Basalt	WI	REG	CR	No
399-2-1	A5043	594,467.2	116,121.2	115.40	Survey	1,5	CME	REG	TU	Yes
399-2-2	A5044	594,385.7	116,282.6	116.10	Survey	1,5	CME	REG	UU	Yes
399-2-3	A5045	594,377.5	116,220.4	115.46	Survey	1,5	CME	REG	UU	Yes
399-3-1	A5046	594,481.3	116,008.0	118.19	Survey	1,5	CME	REG	TU	Yes
399-3-10	A5047	594,530.1	115,832.3	118.49	Survey	1	CME	REG	TU	Yes
399-3-11	A8077	594,309.1	115,793.7	121.47	Survey	1,5	CME	REG	TU	Yes
399-3-12	A5048	594,213.8	115,946.8	119.31	Survey	1	CME	REG	TU	Yes
399-3-6	A5049	593,927.1	115,944.4	120.76	Survey	1,5	CME	REG	TU	Yes
399-3-9	A5051	594,504.5	115,917.9	119.32	Survey	1	CME	REG	UU	Yes
399-4-1	A5052	594,274.1	115,537.3	121.61	Survey	1,5	CME	REG	TU	Yes
399-4-10	A5053	594,566.4	115,655.8	116.41	Survey	1,5	CME	REG	TU	Yes
399-4-11	A5054	594,087.9	115,709.2	124.31	Survey	1,5	CME	REG	TU	Yes
399-4-7	A5055	594,603.2	115,492.6	116.42	Survey	1,5	WI	REG	TU	Yes
399-4-9	A5056	594,537.8	115,741.5	117.52	Survey	1,5	CME	REG	TU	Yes
399-5-1	A5057	593,750.7	115,525.3	121.59	Survey	1,5,6	CME	REG	TU	Yes
399-5-4B	A8094	593,733.8	115,739.8	121.32	Survey	1,5	CME	REG	TU	Yes
399-6-1	A5058	593,527.2	115,807.1	119.53	Survey	1,5	CME	REG	TU	Yes
399-8-1	A5059	593,632.2	116,332.0	121.77	Survey	1,5	WI	REG	TU	Yes
399-8-2	A5060	593,202.4	116,300.4	122.35	Survey	1,5,6	WI	REG	TU	Yes
399-8-3	A5061	593,626.1	116,683.6	121.35	Survey	1,5,6	WI	REG	TU	Yes
399-8-4	A8096	592,872.9	116,296.1	121.11	Survey	1,5	CME	REG	TU	Yes
399-8-5A	A5416	593,384.2	116,565.5	123.03	Survey	1,5	CME	REG	TU	Yes
399-8-5B	A5417	593,392.0	116,567.3	122.89	Survey	7	CME	REG	DU	No
399-8-5C	A5418	593,386.1	116,573.6	122.91	Survey	8,Basalt	WI	REG	CR	No
699-101-48B	A5066	575,283.7	154,404.0	119.93	Survey	5	CME	SURV	UU	Yes
699-10-54A	A5063	573,581.7	126,562.3	158.41	Survey	5	WI	SURV	UU	Yes
699-10-E12	A5065	593,296.2	126,696.6	132.35	Survey	1,5,6,7,8	WI	SURV	U	No
699-10-E12P	A9579	593,296.2	126,696.6	132.35	Survey	Basalt	WI	SURV	CR	No
699-10-E12Q	A9580	593,296.2	126,696.6	132.35	Survey	5	WI	SURV	UU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-11-45A	A5067	576,279.0	126,806.6	177.33	Survey	5	WI	SURV	U	Yes
699-1-18	A8120	584,529.8	123,948.9	164.89	Survey	5	CME	SURV	U	Yes
699-12-4D	A8252	588,689.8	127,257.7	136.78	Survey	1,4,5	CME	SURV	U	Yes
699-13-64	A8272	570,415.9	127,309.0	169.27	Survey	9	WI	SURV	UU	Yes
699-14-38	A5068	578,401.9	127,742.6	157.97	Survey	1,5,6,7,8,9	CME	SURV	U	Yes
699-14-38P	A9583	578,401.9	127,742.6	157.97	Survey	9	CME	SURV	CR	No
699-14-38Q	A9584	578,401.9	127,742.6	157.97	Survey	1	CME	SURV	DU	No
699-14-47	A5069	575,490.2	127,633.7	180.02	Survey	5	CME	SURV	UU	Yes
699-14-E6S	A8314	591,592.9	127,739.8	140.59	Survey	7	CME	SURV	CR	No
699-15-15A	A5071	585,350.7	128,021.2	167.77	Survey	1,4,5,6,7,8	CME	SURV	UU	Yes
699-15-26	A5072	581,770.3	127,963.5	160.66	Survey	1	WI	SURV	TU	Yes
699-17-5	A5073	588,557.9	128,811.8	133.00	Survey	1	WI	SURV	UU	Yes
699-17-70	A5074	568,571.9	128,635.7	172.66	Survey	5	WI	SURV	UU	Yes
699-19-43	A5075	576,819.5	129,159.0	169.13	Survey	1	CME	SURV	UU	Yes
699-19-58	A5076	572,133.5	129,298.8	175.66	Survey	5,8	WI	SURV	UU	Yes
699-19-88	A5077	563,131.1	129,413.9	197.41	Survey	5	WI	SURV	UU	Yes
699-20-20	A5080	583,518.5	129,714.3	155.11	Survey	1	CME	SURV	UU	Yes
699-20-39	A5081	577,999.8	129,731.1	165.58	Survey	1,4,5,6,7,8,9	CME	SURV	UU	Yes
699-20-39P	A9608	577,999.8	129,731.1	165.59	Survey	1,4	CME	SURV	CR	No
699-20-E12	A5085	593,592.9	129,735.3	134.36	Survey	1,4,5	CME	SURV	TU	Yes
699-20-E12P	A9614	593,592.9	129,735.3	134.39	VERTCON	8,Basalt	WI	SURV	CR	No
699-20-E12Q	A9615	593,592.9	129,735.3	134.39	VERTCON	5	WI	SURV	DU	No
699-20-E12R	A9616	593,592.9	129,735.3	134.39	VERTCON	5	WI	SURV	DU	No
699-20-E12S	A9617	593,592.9	129,735.3	134.39	VERTCON	5	WI	SURV	DU	No
699-20-E5A	A8428	591,358.1	129,612.4	143.67	Survey	1	CME	SURV	TU	Yes
699-20-E5T	A8433	591,367.2	129,664.9	143.60	VERTCON	1	CME	SURV	UU	No
699-21-17	A5086	584,791.6	129,855.4	162.47	Survey	1	WI	SURV	U	Yes
699-21-6	A8438	587,982.8	129,941.9	134.08	Survey	1	CME	SURV	TU	Yes
699-22-35	A8443	579,340.6	130,309.0	163.81	VERTCON	1	CME	REG	TU	Yes
699-2-3	A5078	588,851.7	124,186.7	146.37	Survey	1,5	WI	SURV	TU	Yes
699-23-34A	A5087	579,486.3	130,552.4	163.42	Survey	1	CME	REG	TU	Yes
699-2-33A	A5079	580,097.6	124,130.5	164.49	Survey	5	WI	SURV	UU	Yes
699-2-33BP	A9478	580,097.5	124,135.2	164.43	VERTCON	9	CME	SURV	CR	No
699-2-33BQ	A9479	580,097.5	124,135.2	164.43	VERTCON	7	CME	SURV	CR	No
699-24-1Q	A8454	590,393.9	130,725.5	145.89	Survey	6	WI	SURV	DU	No
699-24-1R	A8455	590,399.0	130,747.1	146.60	Survey	6	WI	SURV	DU	No
699-24-1S	A8456	590,401.9	130,758.6	146.19	Survey	5	WI	SURV	DU	No

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-24-1T	A5088	590,396.2	130,735.6	145.97	Survey	1	WI	SURV	UU	Yes
699-24-34B	A5091	579,554.1	130,771.8	163.61	Survey	1	CME	SURV	TU	Yes
699-24-35	A5093	579,176.8	130,915.0	165.23	Survey	1	CME	SURV	TU	Yes
699-24-46	A8457	575,785.7	130,793.8	181.20	Survey	1,5	WI	SURV	UU	Yes
699-25-34C	A5097	579,635.0	131,037.8	164.22	Survey	1	CME	REG	TU	Yes
699-25-55	A5098	573,089.1	131,212.1	207.27	Survey	5	CME	SURV	UU	Yes
699-25-70	A5099	568,544.9	131,171.7	192.97	Survey	5	WI	SURV	TU	Yes
699-26-15A	A5100	585,472.6	131,330.6	136.07	Survey	1	WI	SURV	UU	Yes
699-26-33	A5101	579,709.7	131,280.3	164.31	Survey	1	CME	SURV	TU	Yes
699-26-34A	A5102	579,394.8	131,467.6	162.06	Survey	1	CME	REG	TU	Yes
699-26-34B	A5420	579,629.3	131,352.2	162.63	Survey	1	CME	REG	TU	Yes
699-26-35A	A5103	579,314.1	131,347.3	163.36	Survey	1	CME	REG	TU	Yes
699-26-89	A5108	562,778.7	131,375.1	199.72	Survey	5	WI	SURV	U	Yes
699-2-7	A8122	587,844.8	123,980.0	157.12	Survey	5	WI	SURV	U	Yes
699-27-8	A5109	587,305.0	131,498.4	142.92	Survey	1	CME	SURV	TU	Yes
699-28-40	A5110	577,621.7	131,929.8	171.55	Survey	1,4,5	CME	SURV	U	Yes
699-28-40P	A9628	577,621.7	131,929.8	171.62	Survey	8	CME	SURV	CR	No
699-28-40Q	A9629	577,621.7	131,929.8	171.61	Survey	5,6,7	CME	SURV	CR	No
699-28-52A	A5111	574,187.6	132,109.3	209.64	Survey	5	CME	SURV	UU	Yes
699-29-4	A8490	588,701.2	132,255.3	149.94	Survey	1	CME	SURV	TU	Yes
699-29-70AQ	A5113	568,465.4	132,162.0	193.08	Survey	9	RI	SURV	CR	No
699-29-78	A5121	566,211.6	132,413.6	198.25	Survey	5	CME	SURV	U	No
699-31-31	A5123	580,551.7	132,794.2	162.37	Survey	1,4	WI	SURV	U	Yes
699-31-31P	A9633	580,551.7	132,794.2	162.40	VERTCON	7,8	WI	SURV	CR	No
699-31-31Q	A9634	580,551.7	132,794.2	162.40	VERTCON	5	WI	SURV	DU	No
699-32-22A	A5126	583,197.1	133,256.8	158.77	Survey	1	CME	SURV	U	Yes
699-32-43	A5127	576,902.1	133,278.6	158.50	Survey	1	CME	SURV	TU	Yes
699-32-62	A5128	571,009.6	133,215.9	216.56	Survey	5	WI	SURV	U	Yes
699-32-77	A5131	566,416.8	133,152.5	200.34	Survey	5	WI	REG	TU	Yes
699-33-42	A5132	577,020.6	133,480.7	158.31	Survey	4	CME	SURV	TU	Yes
699-33-56	A5133	572,922.7	133,627.2	219.57	Survey	5,6	WI	SURV	U	Yes
699-34-39A	A5134	578,013.5	133,881.1	164.72	Survey	1,4,5	CME	SURV	TU	Yes
699-34-41B	A5135	577,338.3	133,911.7	175.03	Survey	4,5	CME	SURV	TU	Yes
699-3-45	A5122	576,204.8	124,401.3	154.79	Survey	1	WI	SURV	UU	Yes
699-34-51	A5137	574,269.9	133,808.5	225.54	Survey	5	CME	SURV	U	Yes
699-34-88	A5138	563,011.5	133,950.3	194.04	Survey	5	WI	SURV	UU	Yes
699-35-66A	A5139	569,857.9	134,099.2	222.45	Survey	5	CME	SURV	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-35-70	A5140	568,566.5	133,987.6	212.33	Survey	5	CME	SURV	U	Yes
699-35-78A	A5141	566,063.6	134,271.3	202.38	Survey	5	CME	SURV	TU	Yes
699-35-9	A5142	587,123.0	134,096.1	153.36	Survey	1	CME	SURV	U	Yes
699-36-27	A8566	581,805.3	134,445.7	163.31	VERTCON	1	WI	SURV	U	Yes
699-36-61A	A5144	571,395.5	134,557.1	229.03	Survey	5	WI	SURV	TU	Yes
699-36-70A	A9901	568,466.7	134,308.8	216.05	Survey	5	RI	REG	TU	Yes
699-36-93	A5145	561,549.9	134,415.6	197.53	Survey	5	WI	SURV	U	Yes
699-37-43	A5146	576,828.5	134,782.5	211.36	Survey	4,5	WI	SURV	UU	Yes
699-37-47A	B2822	575,557.0	134,893.3	219.50	Survey	5	RI	REG	TU	Yes
699-38-15	A8594	585,475.3	134,951.3	139.65	Survey	1	WI	SURV	TU	Yes
699-38-65	A5148	570,090.2	135,039.8	230.71	Survey	1,6,9	RI	SURV	U	Yes
699-38-70	A5149	568,500.9	135,089.2	217.70	Survey	5	CME	SURV	UU	Yes
699-39-0	A8600	589,874.1	135,424.4	138.00	Survey	1	CME	SURV	UU	Yes
699-39-79	A5151	565,890.9	135,411.9	206.45	Survey	5	RI	SURV	TU	Yes
699-40-1	A5152	589,721.9	135,665.5	134.71	Survey	1,5,6,7	WI	SURV	TU	Yes
699-40-12C	A8629	586,362.4	135,663.8	158.31	Survey	1	CME	SURV	U	Yes
699-40-20	A8637	583,830.2	135,678.1	147.14	Survey	1	WI	SURV	U	Yes
699-40-33A	A5153	579,680.9	135,822.4	158.92	Survey	5,6	WI	SURV	U	No
699-40-36	A5154	578,789.2	135,633.8	162.24	Survey	7	RI	REG	CR	No
699-40-40A	A5156	577,680.1	135,594.1	165.99	Survey	7,8	RI	REG	CR	No
699-40-62	A5158	571,164.3	135,764.4	228.93	Survey	5	RI	SURV	TU	Yes
699-41-23	A5159	582,921.9	135,903.0	143.40	Survey	1	CME	SURV	U	Yes
699-41-25	A8652	582,249.3	135,887.9	144.17	Survey	1	CME	SURV	U	Yes
699-41-35	A5160	579,079.7	135,947.4	159.64	Survey	7	RI	REG	CR	No
699-41-40	A5161	577,613.9	135,995.9	167.38	Survey	6,7	RI	REG	CR	No
699-41-42	A5162	577,122.0	136,067.9	197.29	Survey	7,8,9,Basalt	RI	REG	DU	No
699-42-12A	A5163	586,331.2	136,445.4	157.78	Survey	5	WI	SURV	UU	Yes
699-42-2	A8660	589,310.4	136,342.7	133.13	Survey	1	CME	SURV	UU	Yes
699-42-37	A5164	578,476.8	136,247.2	159.34	Survey	7	RI	REG	CR	No
699-42-39B	A5166	577,859.0	136,236.4	171.20	Survey	7	RI	REG	CR	No
699-42-40A	A5167	577,638.1	136,421.8	167.16	Survey	8,9	WI	SURV	UU	No
699-42-40B	A5168	577,638.0	136,413.9	167.44	Survey	1,8,9	CME	SURV	CR	Yes
699-42-41	A5170	577,335.2	136,365.6	173.94	Survey	8	CME	REG	CR	Yes
699-42-42B	A5171	576,998.1	136,433.9	178.75	Survey	7	RI	REG	CR	No
699-43-104	A5172	558,106.1	136,543.7	234.81	Survey	5,8	WI	SURV	U	Yes
699-43-40	A5173	577,583.1	136,705.3	166.29	Survey	8	CME	REG	TU	Yes
699-43-41E	A5174	577,478.7	136,594.4	168.89	Survey	8,9	CME	REG	CR	No

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-43-41G	A5176	577,466.4	136,586.6	169.08	Survey	9	RI	REG	CR	No
699-43-42J	A5178	577,006.2	136,451.9	178.28	Survey	8	CME	SURV	CR	Yes
699-43-45	A5180	576,283.8	136,585.7	183.15	Survey	1,9	CME	REG	TU	Yes
699-43-89	A5181	562,917.3	136,620.0	197.72	Survey	5	WI	SURV	U	Yes
699-43-91AQ	A5183	562,223.2	136,667.5	205.87	VERTCON	5	WI	SURV	TB	No
699-44-16	A8705	584,912.1	137,002.4	137.46	VERTCON	1,4,5	WI	SURV	U	Yes
699-44-39B	A5185	577,960.6	136,727.4	157.51	Survey	1	RI	REG	UU	Yes
699-44-42	A5186	577,099.3	136,833.6	177.53	Survey	9	WI	SURV	TU	Yes
699-44-43B	A5187	576,673.3	136,897.7	177.80	Survey	1	CME	REG	TU	Yes
699-44-64	A5188	570,390.7	136,897.4	222.19	Survey	5,8,9,Basalt	CME	SURV	UU	Yes
699-45-42	A5195	577,055.1	137,286.4	177.06	Survey	9	RI	SURV	TU	Yes
699-46-21B	A5197	583,604.1	137,556.9	160.18	Survey	5	WI	SURV	UU	Yes
699-47-35A	A5198	579,312.5	137,780.1	146.21	Survey	1,9	WI	SURV	CR	No
699-47-35B	A5199	579,315.1	137,792.7	146.30	Survey	9	RI	SURV	CR	No
699-47-60	A5202	571,474.4	137,968.7	199.58	Survey	9	RI	SURV	TU	Yes
699-47-80AQ	A5204	565,562.0	137,693.5	218.54	VERTCON	Basalt	WI	SURV	DU	No
699-48-18	A8764	584,426.5	138,726.3	130.39	Survey	1	WI	SURV	TU	Yes
699-48-50	A5212	574,817.6	138,227.1	175.99	Survey	1	CME	SURV	TU	Yes
699-48-71	A5214	568,387.9	138,056.9	210.86	Survey	5	CME	SURV	UU	Yes
699-48-77A	A8772	566,413.2	137,968.9	206.67	Survey	5	CME	REG	TU	Yes
699-48-77C	A8774	566,469.0	138,086.8	206.59	VERTCON	5	WI	REG	DU	No
699-48-77D	A8775	566,433.3	138,119.3	206.46	VERTCON	5	WI	REG	TU	Yes
699-48-96	A8776	560,517.0	138,355.3	246.07	Survey	5,8,9	RI	SURV	U	No
699-49-13E	A5215	586,042.8	138,386.5	126.83	Survey	1	WI	SURV	UU	Yes
699-49-55A	A5217	573,146.3	138,351.8	162.86	Survey	1,Basalt	CME	SURV	TU	Yes
699-49-57A	A5219	572,544.3	138,389.2	169.72	Survey	1	CME	SURV	TU	Yes
699-49-79	A5221	565,771.1	138,271.1	211.08	Survey	5	WI	SURV	UU	Yes
699-50-28B	A5222	581,501.8	138,825.5	164.80	Survey	1	CME	SURV	UU	Yes
699-50-30	A5223	580,810.5	138,847.4	162.22	Survey	1,5	CME	SURV	TU	Yes
699-50-42	A5224	577,111.0	138,786.7	143.34	Survey	6,9	RI	SURV	TB	No
699-50-53A	A5227	573,649.7	138,670.5	170.93	Survey	1,Basalt	CME	SURV	TU	Yes
699-50-85	A5229	564,130.2	138,669.3	226.38	Survey	5	WI	SURV	UU	Yes
699-51-19	A8823	584,151.5	138,981.1	131.03	Survey	1,4,Basalt	WI	SURV	U	No
699-51-63	A5231	570,664.4	139,148.4	175.30	Survey	1,Basalt	CME	SURV	TU	Yes
699-51-75	A5232	566,978.1	138,906.3	196.56	Survey	5	WI	SURV	UU	Yes
699-52-19	A5233	584,209.4	139,318.4	126.31	Survey	1,4	CME	SURV	UU	Yes
699-52-54	A5236	573,254.2	139,193.2	174.27	Survey	1	WI	SURV	TU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-52-57	A5237	572,761.3	139,115.3	172.24	Survey	1	CME	SURV	TU	Yes
699-53-35	A5238	579,288.6	139,708.0	162.88	Survey	1	CME	SURV	U	No
699-53-47A	A5239	575,417.5	139,489.3	134.63	Survey	1,Basalt	CME	SURV	TU	Yes
699-54-18A	A8855	584,488.7	139,996.0	124.31	VERTCON	1	CME	SURV	DU	No
699-54-37A	A5249	578,664.7	139,993.1	163.81	Survey	1,Basalt	CME	SURV	UU	Yes
699-54-42	A5250	576,933.2	140,099.2	156.95	Survey	1	CME	SURV	UU	Yes
699-54-45A	A5251	576,314.8	140,001.4	151.70	Survey	1	CME	SURV	UU	Yes
699-54-48	A5252	575,357.8	139,821.2	140.35	Survey	1	CME	SURV	U	No
699-54-49	A8863	574,988.0	139,825.7	135.06	Survey	1	WI	SURV	TU	Yes
699-55-44	A5256	576,565.6	140,384.1	159.45	Survey	1	CME	SURV	CR	No
699-55-50C	A5257	574,660.4	140,243.4	136.51	Survey	1	CME	SURV	TU	Yes
699-55-55	A5258	573,227.6	140,150.5	172.87	Survey	1	CME	SURV	TU	Yes
699-55-60A	A8868	571,563.0	140,267.4	175.68	VERTCON	1	CME	SURV	U	Yes
699-55-70	A5260	568,530.0	140,319.0	174.44	Survey	1	CME	SURV	UU	Yes
699-55-76	A5261	566,723.4	140,225.8	178.73	Survey	1,3,5	WI	SURV	U	Yes
699-55-89	A5262	562,886.6	140,199.5	185.29	Survey	5	WI	SURV	U	Yes
699-55-95	A5263	560,944.7	140,231.1	238.09	Survey	5	WI	SURV	U	No
699-57-29A	A5267	581,134.0	140,899.7	127.66	Survey	1	RI	SURV	TU	Yes
699-57-59	A5269	571,830.2	140,923.7	176.65	Survey	1	CME	SURV	TU	Yes
699-57-83A	A5270	564,582.8	140,825.1	177.17	Survey	1	WI	SURV	U	Yes
699-58-24	A5275	582,308.8	141,345.9	128.66	Survey	1	CME	SURV	TU	Yes
699-59-32	A5276	580,010.3	141,607.4	130.34	Survey	Basalt	CME	SURV	UU	Yes
699-59-55	A8918	573,049.3	141,544.1	132.66	Survey	Basalt	CME	SURV	DU	No
699-59-58	A5277	572,273.6	141,415.0	152.80	Survey	1	CME	SURV	TU	Yes
699-59-80B	A5278	565,637.7	141,575.0	178.80	Survey	1	CME	SURV	UU	Yes
699-60-32	A5279	580,115.1	141,902.0	130.65	Survey	6,Basalt	WI	SURV	UU	Yes
699-60-57	A5280	572,623.5	141,870.3	144.13	Survey	1	WI	SURV	U	Yes
699-60-60	A5282	571,588.6	141,763.9	157.08	Survey	1	CME	SURV	TU	Yes
699-61-37	A5283	578,587.2	141,964.3	136.06	Survey	1	RI	SURV	UU	Yes
699-61-41	A5284	577,344.6	142,188.4	131.79	Survey	1	RI	SURV	TU	Yes
699-61-62	A5285	570,914.9	141,921.7	152.66	Survey	1	WI	SURV	TU	Yes
699-61-66	A5286	569,787.6	142,008.0	160.19	Survey	1	WI	SURV	UU	Yes
699-62-31	A5287	580,302.6	142,532.5	133.34	Survey	5,6	CME	SURV	UU	Yes
699-62-43A	A5288	576,809.6	142,363.9	132.81	Survey	Basalt	CME	SURV	UU	No
699-63-25A	A5289	582,315.5	142,798.0	121.47	Survey	1,5,6	WI	SURV	U	No
699-63-51	A5290	574,446.8	142,553.7	130.41	Survey	Basalt	CME	SURV	TU	Yes
699-63-55	A5291	573,094.4	142,562.3	131.01	Survey	1	WI	SURV	UU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-63-58	A5292	572,262.7	142,583.1	150.92	Survey	1,5,Basalt	WI	SURV	U	Yes
699-63-90	A5293	562,367.2	142,612.4	156.86	Survey	1,5	WI	SURV	U	Yes
699-64-62	A5296	571,055.8	142,913.9	153.47	Survey	1	CME	SURV	TU	Yes
699-65-22	A5297	583,313.0	143,317.0	120.21	Survey	1	CME	SURV	UU	Yes
699-65-50	A5300	574,590.8	143,187.9	143.37	Survey	1,5,6	WI	SURV	U	Yes
699-65-59A	A5301	571,913.7	143,278.7	155.54	Survey	1	CME	SURV	TU	Yes
699-65-72	A5302	567,883.7	143,107.9	165.68	Survey	1	CME	SURV	TU	Yes
699-65-83	A5303	564,590.5	143,249.1	149.05	Survey	1,5	RI	SURV	UU	Yes
699-66-103	A5305	558,538.8	143,553.3	142.35	Survey	1	CME	SURV	U	Yes
699-66-23	A5306	582,864.8	143,617.2	119.59	Survey	1,6	WI	SURV	U	No
699-66-38	A5307	578,294.0	143,607.7	133.98	Survey	1,5,6	WI	SURV	UU	Yes
699-66-39	A5308	577,847.2	143,636.3	139.33	Survey	5	CME	SURV	TU	Yes
699-66-58	A5309	572,266.7	143,532.7	154.40	Survey	1	CME	SURV	TU	Yes
699-66-64	A5310	570,290.7	143,734.1	155.19	Survey	1	CME	SURV	TU	Yes
699-67-51	A5312	574,178.9	143,933.2	160.88	Survey	1,5,6	CME	SURV	UU	Yes
699-67-51P	A9753	574,178.9	143,933.2	160.89	Survey	6	WI	SURV	CR	No
699-67-51Q	A9754	574,178.9	143,933.2	160.89	Survey	6	WI	SURV	DU	No
699-67-86	A5313	563,661.6	143,873.0	145.02	Survey	1,5,6,8,Basalt	CME	SURV	TU	Yes
699-67-98	A5314	559,944.0	143,714.7	139.84	Survey	1	CME	SURV	U	No
699-68-105	A5315	557,803.3	144,206.1	139.45	Survey	1	CME	SURV	UU	Yes
699-69-38	A5316	578,262.5	144,396.9	130.10	Survey	5	CME	SURV	UU	Yes
699-69-45	A8967	576,157.4	144,556.3	149.43	Survey	1,5,6	CME	SURV	U	No
699-69-45O	A5317	576,157.4	144,556.3	149.48	Survey	5	WI	SURV	UU	Yes
699-69-45P	A9759	576,157.4	144,556.3	149.49	Survey	6	WI	SURV	CR	No
699-69-45Q	A9760	576,157.4	144,556.3	149.49	Survey	5,6	WI	SURV	CR	No
699-69-45R	A9761	576,157.4	144,556.3	149.49	Survey	6	WI	SURV	CR	No
699-70-23	A5318	582,790.9	144,895.8	120.38	Survey	6	CME	SURV	UU	Yes
699-70-68	A5319	569,021.8	144,845.4	161.38	Survey	1	CME	SURV	UU	Yes
699-71-30	A5320	580,603.3	145,226.9	123.13	Survey	1,6	WI	SURV	U	No
699-71-52	A5321	573,907.9	145,214.8	160.43	Survey	1,5,6	WI	SURV	U	No
699-71-77	A5322	566,402.0	145,098.6	144.96	Survey	1,5,6	WI	SURV	U	Yes
699-72-73	A5323	567,551.5	145,418.8	148.13	Survey	1,5,6	WI	SURV	U	Yes
699-72-88	A5324	563,247.3	145,359.9	133.10	Survey	1	CME	SURV	TU	Yes
699-72-92	A5325	561,839.4	145,359.8	138.05	Survey	1,5	WI	SURV	UU	Yes
699-73-61	A5327	571,420.8	145,781.5	163.01	Survey	1	WI	SURV	TU	Yes
699-74-44	A5328	576,393.1	146,098.8	136.70	Survey	1	WI	SURV	TU	Yes
699-77-36	A5330	578,847.2	146,868.9	126.67	Survey	1,6	WI	SURV	UU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-77-54	A5331	573,386.0	146,854.8	147.35	Survey	1,5	WI	SURV	UU	Yes
699-78-62	A5332	570,877.3	147,166.2	144.20	Survey	5	CME	SURV	U	Yes
699-80-43P	A8993	576,703.9	147,729.9	127.14	Survey	9,Basalt	WI	SURV	CR	No
699-80-43S	A5336	576,701.9	147,774.7	126.82	Survey	1,6	WI	SURV	UU	Yes
699-81-38	A5337	578,172.3	148,241.6	124.89	Survey	1	CME	SURV	UU	Yes
699-81-58	A5338	572,185.4	148,173.4	134.99	Survey	5,6	CME	REG	UU	Yes
699-8-17	A5333	584,675.0	126,017.9	160.27	Survey	1	WI	SURV	U	Yes
699-8-25	A5334	582,299.0	125,935.6	156.25	Survey	1	WI	SURV	U	Yes
699-8-32	A5335	580,385.0	125,978.7	170.01	Survey	1	WI	SURV	U	Yes
699-83-47	A5341	575,492.0	148,705.2	133.70	Survey	1,6	WI	SURV	UU	Yes
699-84-35AO	A9769	579,193.1	149,093.7	123.03	Survey	1	WI	SURV	U	No
699-84-35AP	A9770	579,193.1	149,093.7	123.03	Survey	8	WI	SURV	CR	No
699-84-35AQ	A9771	579,193.1	149,093.7	123.03	Survey	7	WI	SURV	DU	No
699-84-35AR	A9772	579,193.1	149,093.7	123.03	Survey	7	WI	SURV	DU	No
699-84-35AS	A9773	579,193.1	149,093.7	123.03	Survey	7	WI	SURV	DU	No
699-86-42	A5344	577,015.9	149,603.9	125.94	Survey	1	CME	SURV	UU	Yes
699-87-42A	A5345	576,955.2	150,059.1	127.97	Survey	1	CME	SURV	UU	Yes
699-87-55	A5346	572,969.8	149,904.0	141.12	Survey	5	WI	REG	TU	Yes
699-88-41	A5347	577,221.5	150,333.8	127.82	Survey	1	CME	SURV	UU	Yes
699-89-35	A5348	579,121.7	150,543.5	122.35	Survey	1,6	CME	SURV	UU	Yes
699-90-45	A5352	576,169.3	151,024.5	129.51	Survey	1	CME	REG	UU	Yes
699-91-46A	A5354	575,911.0	151,156.6	128.13	Survey	1	CME	REG	TU	Yes
699-93-48A	A5356	575,094.1	151,795.3	134.45	Survey	1	WI	REG	TU	Yes
699-96-43	A5357	576,761.5	152,605.3	129.59	Survey	1,6	WI	SURV	TU	Yes
699-96-49	A5358	574,851.3	152,858.1	128.81	Survey	1,6	CME	REG	U	No
699-96-49P	A9775	574,851.3	152,858.1	128.81	Survey	6	WI	SURV	DU	No
699-97-43	A5360	576,671.9	153,090.3	129.60	Survey	1,6	WI	SURV	UU	Yes
699-97-51A	A5362	574,468.1	153,122.1	123.64	Survey	1	CME	REG	TU	Yes
699-9-E2	A5349	590,618.6	126,132.2	128.51	Survey	1,5	WI	SURV	TU	Yes
699-S11-E12A	A9181	593,576.4	120,173.5	112.51	Survey	1,5,6,7,8	CME	SURV	U	Yes
699-S12-29	A5365	580,739.6	119,809.6	149.66	Survey	1	WI	SURV	UU	Yes
699-S12-29P	A9780	580,739.6	119,809.6	149.66	Survey	Basalt	WI	SURV	TB	No
699-S12-29Q	A9781	580,739.6	119,809.6	149.66	Survey	8	WI	SURV	CR	No
699-S12-3	A5366	589,286.1	119,631.8	133.73	Survey	5	WI	SURV	UU	Yes
699-S14-20A	A5367	583,899.0	119,084.4	151.28	Survey	1,8	CME	SURV	U	Yes
699-S18-E2A	A5368	590,573.5	117,895.2	133.56	Survey	1,5,8	WI	SURV	U	No
699-S18-E2AP	A9785	590,573.5	117,895.2	133.67	VERTCON	Basalt	WI	SURV	DU	No

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-S18-E2B	A9199	590,574.8	117,891.8	133.38	Survey	1,5,7,8,Basalt	CME	SURV	U	No
699-S19-11	A5369	586,582.4	117,799.3	148.49	Survey	5	CME	SURV	UU	Yes
699-S19-E13	A5370	593,835.3	117,605.1	121.26	Survey	1,5	CME	SURV	UU	Yes
699-S19-E14	A5421	594,249.9	117,716.2	114.97	Survey	1	CME	SURV	TU	Yes
699-S22-E9A	A5422	592,688.2	116,761.7	115.07	Survey	1,5	CME	SURV	TU	Yes
699-S22-E9B	A5423	592,696.1	116,756.4	114.91	Survey	7	CME	SURV	DU	No
699-S22-E9C	A5424	592,689.0	116,752.6	114.48	Survey	Basalt	WI	SURV	TB	No
699-S24-19Q	B2782	584,069.0	116,258.9	130.32	Survey	1,5	WI	SURV	UU	Yes
699-S27-E12A	B2420	593,427.8	115,177.9	119.59	Survey	1,5,6	CME	REG	TU	Yes
699-S27-E14	A5371	594,114.1	115,212.7	123.48	Survey	1,5,6	WI	REG	UU	Yes
699-S27-E9A	A5425	592,720.7	115,332.3	119.97	Survey	5	CME	SURV	TU	Yes
699-S27-E9B	A5426	592,727.3	115,328.7	120.02	Survey	7,8	CME	SURV	DU	No
699-S27-E9C	A5427	592,720.9	115,324.8	120.06	Survey	Basalt	WI	SURV	TB	No
699-S28-E12	A5428	593,538.1	115,000.7	119.81	Survey	1,5,6	CME	SURV	TU	Yes
699-S28-E13A	B2419	593,726.4	114,789.6	119.80	Survey	1,5,6	CME	REG	TU	Yes
699-S29-E10A	B2422	592,989.9	114,771.4	120.16	Survey	1,5	CME	REG	TU	Yes
699-S29-E11	A9207	593,175.9	114,591.3	118.56	Survey	1,5	CME	SURV	TU	Yes
699-S29-E12	A5372	593,626.0	114,569.5	119.26	Survey	1,5,6	CME	SURV	UU	Yes
699-S29-E13A	B2418	593,932.7	114,492.5	119.92	Survey	1,5	CME	REG	TU	Yes
699-S29-E16A	A5429	594,750.6	114,731.1	116.76	Survey	1,5	WI	SURV	TU	Yes
699-S29-E16B	A5430	594,746.9	114,738.8	116.80	Survey	5,8	WI	SURV	DU	No
699-S29-E16C	A5431	594,742.4	114,730.5	116.68	Survey	8,Basalt	WI	SURV	CR	No
699-S30-E10A	A5375	592,861.8	114,379.6	120.58	Survey	1,5	CME	REG	TU	Yes
699-S30-E15A	A5377	594,470.9	114,308.4	123.16	Survey	1,5	WI	SURV	UU	Yes
699-S31-1	A5378	589,749.3	114,213.3	141.24	Survey	1	WI	SURV	UU	Yes
699-S31-1P	A9786	589,749.3	114,213.3	141.28	VERTCON	Basalt	WI	SURV	TB	No
699-S31-E10B	A5380	592,959.5	114,149.2	117.97	Survey	1	CME	SURV	TU	Yes
699-S31-E10C	A5381	592,966.9	114,154.7	117.72	Survey	5	CME	SURV	UU	No
699-S31-E10E	A9216	592,966.2	114,142.2	117.87	Survey	6	CME	SURV	DU	No
699-S31-E11	A9220	593,425.1	114,157.1	119.12	Survey	1,5	CME	SURV	TU	Yes
699-S31-E8A	A5384	592,251.8	113,933.5	115.25	Survey	1	CME	REG	TU	Yes
699-S3-25	A5373	582,460.3	122,586.1	160.61	Survey	5	WI	SURV	UU	Yes
699-S32-E11	A9223	593,163.1	113,724.5	118.93	Survey	1,5	CME	REG	TU	Yes
699-S32-E13A	A5385	593,963.4	113,886.1	120.02	Survey	1,5	CME	REG	UU	Yes
699-S32-E13B	A5386	593,786.8	113,881.4	121.32	Survey	1,5	CME	SURV	UU	Yes
699-S32-E8	A5387	592,263.8	113,922.4	115.47	Survey	5,6	CME	SURV	CR	No
699-S33-2A	B8102	589,358.2	113,525.7	143.19	VERTCON	1,5	CME	SURV	UU	Yes

Table A.1. Onsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Hydrogeologic Unit(s) Monitored	Hydrogeologic Unit(s) Source	Regulatory Class	Relative Monitoring Zone	Used for Water-Table Map?
699-S34-2A	B8103	589,370.2	113,241.8	146.71	VERTCON	1,5	CME	SURV	UU	Yes
699-S34-2B	B8104	589,362.2	112,996.1	141.01	VERTCON	1,5	CME	SURV	UU	Yes
699-S34-4A	B8105	588,542.2	113,255.4	149.23	VERTCON	5	CME	SURV	UU	Yes
699-S34-E10	A5388	592,948.8	113,043.9	117.55	Survey	1	CME	SURV	TU	Yes
699-S34-E15	A5389	594,509.8	113,086.2	123.91	Survey	1	CME	SURV	TU	Yes
699-S36-E12B	A5391	593,717.9	112,500.8	122.66	Survey	1,5	CME	SURV	UU	Yes
699-S36-E13A	A5392	593,869.5	112,651.5	122.72	Survey	1,5,6	CME	SURV	U	Yes
699-S36-E13B	A9226	593,869.2	112,497.4	122.82	Survey	1,5	CME	SURV	DU	No
699-S37-E11A	A5393	593,401.2	112,172.4	122.73	Survey	1	CME	SURV	TU	Yes
699-S37-E12A	A9232	593,599.3	112,104.2	123.89	Survey	1	CME	SURV	TU	Yes
699-S37-E14	A5394	594,216.0	112,168.6	125.46	Survey	1	CME	REG	TU	Yes
699-S38-E11	A5395	593,153.9	111,891.5	122.51	Survey	1	CME	SURV	TU	Yes
699-S38-E12A	A5396	593,626.6	111,987.3	124.44	Survey	1	CME	SURV	TU	Yes
699-S38-E12B	A5397	593,626.6	111,980.3	124.46	Survey	5,6	CME	SURV	UU	No
699-S3-E12	A5374	593,586.2	122,551.4	122.30	Survey	1,5	WI	SURV	UU	Yes
699-S40-E13A	A9238	593,983.2	111,249.9	125.69	Survey	1	CME	SURV	TU	Yes
699-S40-E13B	A9239	594,024.1	111,197.2	125.64	Survey	1	CME	SURV	TU	Yes
699-S40-E13C	A9240	593,987.3	111,189.0	125.74	Survey	1	CME	SURV	TU	No
699-S40-E14	A5398	594,201.6	111,416.2	123.81	Survey	1	CME	REG	TU	Yes
699-S41-E11A	A5399	593,310.8	110,973.5	123.35	Survey	1	CME	SURV	TU	Yes
699-S41-E12	A5400	593,471.4	111,039.1	123.53	Survey	1,5	CME	SURV	TU	Yes
699-S41-E13A	A5401	593,862.7	111,031.7	126.16	Survey	1	CME	SURV	TU	Yes
699-S41-E13B	A5402	593,863.2	111,041.8	126.01	Survey	5	CME	SURV	UU	No
699-S41-E13C	A5403	593,870.5	111,036.1	126.19	Survey	6,7	CME	SURV	DU	No
699-S42-E8A	A9998	592,558.0	110,639.0	110.70	VERTCON	1,5	CME	SURV	UU	No
699-S42-E8B	A9999	592,569.0	110,673.0	110.42	VERTCON	1,5	CME	SURV	UU	No
699-S43-E12	A5404	593,612.8	110,404.4	124.64	Survey	1	CME	REG	TU	Yes
699-S43-E7A	A9997	592,301.0	110,185.0	111.55	VERTCON	1	CME	REG	UU	Yes
699-S6-E14A	A5405	594,262.4	121,569.4	116.32	Survey	1,5	WI	SURV	UU	Yes
699-S6-E4D	A5406	591,076.9	121,774.7	132.21	Survey	1	CME	SURV	U	No
699-S8-19	A5408	584,225.9	120,963.7	154.62	Survey	1,5	WI	SURV	UU	Yes
SPC-P-1	B8106	591,256.8	113,043.3	128.42	VERTCON	1	CME	SURV	TU	Yes

Table A.2. Offsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Relative Monitoring Zone	Measurement Frequency
08N30E03A01	B8561	612,741.7	98,346.1	119.89	VERTCON	TU	5 Years
09N29E09C01	B8564	600,772.3	106,504.6	157.70	VERTCON	UU	Annual
09N29E12A01	B8565	606,597.4	106,387.2	127.82	VERTCON	UU	5 Years
09N29E15N01	B8566	602,022.3	103,437.2	123.56	VERTCON	UU	5 Years
09N30E02B01	B8567	614,183.1	108,347.0	156.17	VERTCON	UU	5 Years
09N30E06D01	B8568	606,844.4	108,213.5	135.45	VERTCON	TU	5 Years
09N30E17C01	B8571	608,726.0	104,726.2	130.57	VERTCON	TU	5 Years
09N30E29K01	B8573	609,220.9	100,998.8	116.24	VERTCON	UU	5 Years
10N29E01A01	B8576	606,521.3	118,058.4	203.13	VERTCON	UU	5 Years
10N29E08R01	B8577	600,165.5	114,738.6	190.32	VERTCON	UU	5 Years
10N29E11N01	B8578	603,604.0	114,950.8	200.38	VERTCON	UU	5 Years
10N29E15D01	B8579	601,812.5	114,704.8	188.49	VERTCON	UU	5 Years
10N29E26A01	B8581	605,009.8	111,547.7	152.21	VERTCON	TU	Annual
10N29E27C01	B8582	602,550.8	111,505.6	148.55	VERTCON	UU	Annual
10N29E28B01	B8583	600,967.9	111,479.1	154.65	VERTCON	TU	Annual
10N30E03Q02	B8585	612,717.0	116,997.6	196.42	VERTCON	UU	5 Years
10N30E04E01	B8586	609,906.1	117,594.1	170.51	VERTCON	TU	Annual
10N30E05B01	B8587	609,106.1	118,104.4	180.88	VERTCON	TU	5 Years
10N30E05N01	B8588	608,344.7	116,454.3	169.60	VERTCON	TU	5 Years
10N30E08F01	B8589	608,805.5	115,814.5	165.02	VERTCON	UU	Annual
10N30E14N01	B8590	613,211.9	113,362.6	218.67	VERTCON	TU	5 Years
10N30E21R01	B8592	611,552.7	111,725.5	185.44	VERTCON	UU	5 Years
11N28E25R02	B8593	596,902.2	119,595.7	263.18	VERTCON	UU	5 Years
11N29E05D01	B8594	598,586.3	127,682.4	280.57	VERTCON	UU	5 Years
11N29E14R01	B8595	604,983.9	122,910.8	239.11	VERTCON	TU	5 Years
11N29E16N01	B8596	600,203.1	122,798.7	279.04	VERTCON	UU	5 Years
11N29E19R01	B8597	598,521.2	121,197.0	267.75	VERTCON	UU	5 Years
11N29E26D01	B8599	603,433.8	121,185.5	254.34	VERTCON	TU	5 Years
11N30E06N01	B8600	606,677.9	126,152.1	260.76	VERTCON	UU	5 Years
11N30E08N01	B8601	608,199.7	124,573.8	228.75	VERTCON	TU	5 Years
11N30E32D01	B8602	608,286.8	119,696.1	204.66	VERTCON	UU	5 Years
12N28E11J01	B8603	595,206.4	135,039.8	204.68	VERTCON	TU	Annual
12N29E01M01	B8605	605,029.8	136,251.9	224.50	VERTCON	UU	Annual
12N29E03R01	B8606	603,266.6	135,974.8	226.63	VERTCON	TU	Annual
12N29E15D01	B8607	601,825.8	134,220.5	219.92	VERTCON	TU	Annual
12N29E25D01	B8608	605,034.7	131,063.7	283.63	VERTCON	TU	5 Years
12N29E33D01	B8609	600,178.6	129,438.4	279.36	VERTCON	UU	5 Years
12N30E18D01	B8610	606,579.6	134,179.0	294.60	VERTCON	TU	5 Years
12N30E30R01	B8611	608,112.6	129,450.4	222.36	VERTCON	TU	5 Years
13N28E03A01	B8612	593,169.3	146,896.4	303.77	VERTCON	UU	5 Years
13N28E03N01	B8613	591,597.9	145,359.3	295.84	VERTCON	UU	5 Years
13N28E14B01	B8614	594,243.3	143,516.9	297.97	VERTCON	UU	5 Years
13N28E16J01	B8615	591,550.8	142,857.3	287.30	VERTCON	UU	5 Years
13N28E22B01	B8616	592,631.8	141,762.1	294.62	VERTCON	UU	5 Years
13N28E24D01	B8617	595,098.0	141,923.9	290.96	VERTCON	UU	5 Years
13N28E26R01	B8618	594,695.4	139,107.2	287.90	VERTCON	UU	5 Years
13N28E27Q01	B8619	592,951.9	138,925.6	283.93	VERTCON	UU	5 Years
13N29E20D01	B8622	598,180.1	142,190.0	303.45	VERTCON	UU	5 Years
13N29E32D01	B8623	598,470.1	138,735.1	290.95	VERTCON	UU	5 Years
13N29E36D01	B8624	604,725.3	139,088.2	236.08	VERTCON	TU	Annual
13N30E28D01	B8625	609,614.1	140,780.2	272.96	VERTCON	UU	5 Years
13N30E30H01	B8626	607,942.8	140,163.1	262.29	VERTCON	UU	5 Years
14N25E01D02	B8628	565,571.4	156,322.2	206.51	VERTCON	UU	5 Years
14N25E03E01	B8629	562,416.3	155,516.0	206.81	VERTCON	UU	5 Years
14N25E05N01	B8630	559,176.1	154,649.6	223.89	VERTCON	UU	5 Years
14N25E10J01	B8631	563,877.2	153,926.2	196.14	VERTCON	UU	5 Years

Table A.2. Offsite Wells in the Unconfined Aquifer System Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Relative Monitoring Zone	Measurement Frequency
14N25E17A01	B8632	560,721.5	153,028.7	210.47	VERTCON	UU	5 Years
14N27E03PA	B8633	582,169.1	155,136.3	206.51	VERTCON	DU	Annual
14N27E03PB	B8634	582,169.1	155,136.3	206.51	VERTCON	DU	Annual
14N28E30D01	B8644	586,728.0	149,702.9	225.73	VERTCON	UU	5 Years
14N29E21A01	B8647	601,187.4	151,967.1	309.87	VERTCON	UU	5 Years
14N29E28A01	B8648	601,213.9	150,392.3	283.35	VERTCON	UU	5 Years
15N24E26R01	B8649	555,938.7	157,922.3	274.49	VERTCON	UU	5 Years
15N24E34Q01	B8650	553,767.4	156,266.2	243.40	VERTCON	UU	5 Years
15N24E35J01	B8651	555,906.1	156,903.8	259.86	VERTCON	UU	5 Years
15N25E25E01	B8652	565,501.4	158,822.6	264.42	VERTCON	UU	5 Years
15N25E30H01	B8653	559.071.3	158,786.0	265.04	VERTCON	UU	5 Years
15N25E30R01	B8654	559,228.5	157,953.8	248.27	VERTCON	UU	5 Years
15N25E32N01	B8655	559,202.1	156,286.1	233.03	VERTCON	UU	5 Years
15N25E34D01	B8656	562,326.9	157,955.1	241.56	VERTCON	UU	5 Years
15N26E30H01	B8657	568,620.1	158,887.4	261.37	VERTCON	UU	5 Years
699-42-E9AO	A9694	592,435.1	136,324.5	119.06	VERTCON	TU	Annual

Table A.3. Wells in the Upper Basalt-Confined Aquifer System Used for Water-Level Monitoring by the Groundwater Project

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Principal Hydrogeologic Unit(s) Monitored
14N27E03PC	B8635	582,169.1	155,136.3	206.51	VERTCON	Upper Saddle Mountains Basalt
199-H4-2	A5686	578,093.6	152,501.5	129.41	VERTCON	Rattlesnake Ridge Interbed
299-E16-1	A4727	575,782.7	135,219.9	212.87	Survey	Elephant Mountain Interflow Zone
299-E26-8	A4805	575,522.2	136,687.2	189.82	Survey	Rattlesnake Ridge Interbed
299-E33-12	A4839	573,780.5	137,632.2	191.05	Survey	Rattlesnake Ridge Interbed
399-5-2	A8091	592,814.5	115,454.7	120.35	Survey	Levey Interbed and Elephant Mountain Interflow Zone
699-13-1C	A8262	589,587.9	127,321.2	135.27	Survey	Elephant Mountain Interflow Zone and Rattlesnake Ridge Interbed
699-22-70P	A9480	568,798.3	130,165.7	188.47	Survey	Upper Saddle Mountains Basalt
699-22-70Q	A9481	568,798.3	130,165.7	188.47	Survey	Rattlesnake Ridge Interbed and Pomona Basalt
699-24-1P	A8453	590,390.4	130,712.6	145.67	Survey	Rattlesnake Ridge Interbed and Pomona Basalt
699-26-15C	A8468	585,473.6	131,359.3	135.88	Survey	Upper Saddle Mountains Basalt
699-26-83A	A8476	564,532.1	131,300.4	195.10	Survey	Upper Saddle Mountains Basalt
699-29-70AP	A5112	568,465.4	132,162.0	192.97	Survey	Rattlesnake Ridge Interbed
699-29-83	A8494	564,510.0	132,372.3	191.12	Survey	Upper Saddle Mountains Basalt
699-32-22B	A8512	583,199.8	133,240.1	158.58	Survey	Rattlesnake Ridge Interbed
699-40-84	A8644	564,246.0	135,751.3	196.14	Survey	Upper Saddle Mountains Basalt
699-42-40C	A5169	577,644.4	136,417.9	167.35	Survey	Rattlesnake Ridge Interbed
699-42-E9B	A8674	592,466.5	136,265.2	118.76	Survey	Upper Saddle Mountains Basalt
699-43-91AP	A5182	562,223.2	136,667.5	205.74	VERTCON	Rattlesnake Ridge Interbed
699-46-32	A8736	580,265.5	137,574.7	144.93	Survey	Rattlesnake Ridge Interbed
699-47-50	A5201	574,798.7	137,887.2	179.09	Survey	Rattlesnake Ridge Interbed
699-47-80AP	A5203	565,562.0	137,693.5	218.40	VERTCON	Rattlesnake Ridge Interbed
699-49-32B	A8792	580,175.4	138,299.2	158.40	Survey	Rattlesnake Ridge Interbed
699-49-55B	A5218	573,138.7	138,350.9	162.89	Survey	Rattlesnake Ridge Interbed
699-49-57B	A5220	572,536.5	138,381.0	170.47	Survey	Rattlesnake Ridge Interbed
699-50-42P	A9486	577,111.0	138,786.7	143.35	Survey	Upper Saddle Mountains Basalt
699-50-45	A5225	576,172.8	138,783.4	138.63	Survey	Rattlesnake Ridge Interbed
699-50-48B	A5226	575,390.7	138,715.9	168.78	Survey	Rattlesnake Ridge Interbed
699-50-53B	A5228	573,655.5	138,659.5	170.98	Survey	Rattlesnake Ridge Interbed
699-51-36B	A8825	578,921.6	139,065.8	159.12	Survey	Upper Saddle Mountains Basalt
699-51-36D	A8827	578,944.8	139,018.8	158.20	Survey	Upper Saddle Mountains Basalt
699-51-46	A5230	575,738.5	139,001.6	136.55	Survey	Rattlesnake Ridge Interbed
699-52-46A	A5234	575,903.3	139,358.0	139.90	Survey	Rattlesnake Ridge Interbed
699-52-48	A5235	575,231.5	139,195.7	143.08	Survey	Rattlesnake Ridge Interbed
699-53-50	A5243	574,584.1	139,700.6	136.44	Survey	Rattlesnake Ridge Interbed
699-54-34	A5248	579,497.7	140,009.5	168.75	Survey	Upper Saddle Mountains Basalt
699-54-45B	A8862	576,316.1	140,015.7	151.29	Survey	Rattlesnake Ridge Interbed
699-54-57	A5253	572,619.4	140,029.6	176.64	Survey	Rattlesnake Ridge Interbed
699-56-43	A5264	576,756.3	140,627.5	165.77	Survey	Upper Saddle Mountains Basalt
699-56-53	A5265	573,794.2	140,650.7	133.41	Survey	Rattlesnake Ridge Interbed
699-S24-19P	B2781	584,069.0	116,258.9	130.32	Survey	Levey Interbed

Table A.4. Wells in the Lower Basalt-Confined Aquifers Used for Water-Level Monitoring by the Groundwater Project

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Principal Hydrogeologic Unit(s) Monitored
699-17-47	A8370	575,489.8	128,765.2	177.12	Survey	Mabton Interbed
699-20-41P	A5082	577,710.2	129,511.8	163.18	VERTCON	Umtanum Flow Top
699-20-41Q	A5083	577,710.2	129,511.8	163.18	VERTCON	Ginko Interflow Zone
699-20-41R	A5084	577,710.2	129,511.8	163.18	VERTCON	Priest Rapids Interflow Zone
699-25-80	A8465	565,675.8	131,106.0	188.99	Survey	Umatilla Basalt and Mabton
699-26-83BP	A5105	564,634.6	131,319.3	194.39	VERTCON	Umtanum Flow Top
699-26-83BQ	A5106	564,634.6	131,319.3	194.39	VERTCON	Rocky Coulee-Levering Interflow Zone
699-26-83BR	A5107	564,634.6	131,319.3	194.39	VERTCON	Priest Rapids Interflow Zone
699-29-70CP	A5114	568,494.2	132,246.6	193.28	Survey	Umtanum Flow Top
699-29-70CQ	A5115	568,494.2	132,246.6	193.33	Survey	Cohassett Flow Top
699-29-70CR	A5116	568,494.2	132,246.6	193.38	Survey	Rocky Coulee Flow Top
699-29-70CS	A5117	568,494.2	132,246.6	193.43	Survey	Ginko Flow Top
699-29-70CT	A5118	568,494.2	132,246.6	193.49	Survey	Sentinel Gap Flow Top
699-29-70CU	A5119	568,494.2	132,246.6	193.54	Survey	Priest Rapids Interflow Zone
699-29-70DP	A5120	568,531.7	132,221.0	193.85	VERTCON	Mabton Interbed
699-31-84B	A5125	564,381.6	132,984.3	191.73	Survey	Mabton Interbed and Upper Priest Rapids Basalt
699-35-27	A8554	581,536.1	134,066.4	163.10	Survey	Mabton Interbed?
699-39-84CP	A9482	564,337.7	135,566.1	195.74	Survey	GR-5 Flow Interior
699-39-84CQ	A9519	564,337.7	135,566.1	195.69	Survey	GR-5 Flow Top
699-39-84CR	A9483	564,337.7	135,566.1	195.65	Survey	Cohassett Flow Interior
699-39-84CS	A9520	564,337.7	135,566.1	195.60	Survey	Cohassett Flow Top
699-39-84CT	A9521	564,337.7	135,566.1	195.55	Survey	Rocky Coulee Flow Interior
699-39-84CU	A9522	564,337.7	135,566.1	195.49	Survey	Rocky Coulee Flow Top
699-43-91DP	B2435	562,112.4	136,696.3	206.14	VERTCON	Mabton Interbed
699-44-91P	A5189	562,147.0	136,717.3	205.94	VERTCON	Umtanum Flow Top
699-44-91Q	A5190	562,147.0	136,717.3	205.99	VERTCON	Cohassett Flow Top
699-44-91R	A5191	562,147.0	136,717.3	206.04	VERTCON	Rocky Coulee Flow Top
699-44-91S	A5192	562,147.0	136,717.3	206.10	VERTCON	Ginko Flow Top
699-44-91T	A5193	562,147.0	136,717.3	206.15	VERTCON	Sentinel Gap Flow Top
699-44-91U	A5194	562,147.0	136,717.3	206.20	VERTCON	Priest Rapids Interflow Zone
699-47-80CP	A5205	565,530.3	137,718.2	218.26	VERTCON	Umtanum Flow Top
699-47-80CQ	A5206	565,530.3	137,718.2	218.31	VERTCON	Cohassett Flow Top
699-47-80CR	A5207	565,530.3	137,718.2	218.36	VERTCON	Rocky Coulee Flow Top
699-47-80CS	A5208	565,530.3	137,718.2	218.42	VERTCON	Ginko Flow Top
699-47-80CT	A5209	565,530.3	137,718.2	218.46	VERTCON	Sentinel Gap Flow Top
699-47-80CU	A5210	565,530.3	137,718.2	218.52	VERTCON	Priest Rapids Interflow Zone
699-47-80DP	A5211	565,494.2	137,778.9	218.41	Survey	Mabton Interbed
699-48-48AP	A9719	575,196.6	138,112.7	176.44	VERTCON	GR-20 Flow Bottom
699-48-48AQ	A9720	575,196.6	138,112.7	175.99	VERTCON	Shear/Fault Zone within the GR-12 to GR-20 Flows
699-48-48AR	A9721	575,196.6	138,112.7	176.09	VERTCON	GR-11 Flow Bottom
699-48-48AS	A9722	575,196.6	138,112.7	175.90	VERTCON	McCoy Canyon Flow Top
699-48-48AT	A9723	575,196.6	138.112.7	175.71	VERTCON	Wanapum Basalt
699-49-100A	A8802	559,300.9	138,507.0	242.65	VERTCON	Priest Rapids Member
699-51-36A	A8824	578,948.1	139,108.4	159.38	Survey	Mabton Interbed
699-51-36C	A8826	578,990.5	139,081.9	158.98	Survey	Selah Interbed?
699-52-52	A8842	573,920.5	139,293.9	170.96	Survey	Mabton Interbed
699-53-103	A8850	558,363.5	139,513.2	256.18	Survey	Priest Rapids and Roza Basalts
699-53-111	A8851	555,929.1	139,585.0	283.36	Survey	(unknown)
699-53-114	A8852	555,121.7	139,477.5	297.70	Survey	(unknown)
699-57-83BP	A5271	564,528.5	140,821.9	177.38	Survey	Ginko Interflow Zone

Table A.4. Wells in the Lower Basalt-Confined Aquifers Used for Water-Level Monitoring by the Groundwater Project (contd)

Well Name	Well ID	Easting (m)	Northing (m)	Reference Point Elevation (m above MSL)	Reference Point Elevation Source	Principal Hydrogeologic Unit(s) Monitored
699-57-83BQ	A5272	564,528.5	140,821.9	177.43	Survey	Roza Flow Bottom
699-57-83BR	A5273	564,528.5	140,821.9	177.48	Survey	Priest Rapids Interflow Zone
699-57-83C	A5274	564,528.8	140,762.3	177.70	Survey	Umtanum Flow
699-61-55B	A8934	573,010.9	141,983.4	142.06	Survey	Umatilla Basalt, Mabton Interbed, and Priest Rapids Basalt
699-61-57	A8935	572,608.2	142,435.1	135.62	Survey	Lower Umtanum Basalt and Upper Mabton Interbed
699-63-95	A8958	560,914.6	142,650.8	148.78	Survey	Lolo and Rosalia Flows
699-S16-24	A9189	582,765.1	118,539.4	163.24	Survey	Umatilla Basalt and Mabton
699-S30-E14	A9209	594,368.0	114,270.3	123.35	Survey	Frenchman Springs Basalt

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