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E. J. Jensen

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Prepared for the U.S. Department of Energy
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Pacific Northwest Laboratory
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Pacific Northwest Laboratory
Richland, Washington 99352

EXECUTIVE SUMMARY

During 1986, Pacific Northwest Laboratory conducted a study of a portion of the Rattlesnake Ridge aquifer (confined aquifer) that lies beneath the B Pond - Gable Mountain Pond area of the Hanford Site. The purpose of this study was to determine the extent of intercommunication between the unconfined aquifer and the uppermost regionally extensive confined aquifer, referred to as the Rattlesnake Ridge aquifer.

Hydraulic head data and chemical data were collected from the ground water in the study area during December 1986. The hydraulic head data were used to determine the effects caused by water discharged to the ground from B Pond on both the water table of the unconfined aquifer and the potentiometric surface of the confined aquifer. The chemical data were collected to determine the extent of chemical constituents migrating from the unconfined aquifer to the confined aquifer.

Analysis of chemical constituents in the Rattlesnake Ridge aquifer demonstrated that communication between the unconfined and confined aquifers had occurred. However, the levels of contaminants found in the Rattlesnake Ridge aquifer during this study were below the DOE Derived Concentration Guides (PNL 1987).

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INTRODUCTION

The purpose of this task of the Hanford Ground-Water Monitoring Project (funded by the U.S. Department of Energy) was to monitor the uppermost regionally extensive confined aquifer in the Columbia River Basalt Group, the Rattlesnake Ridge aquifer. This monitoring, done to determine the extent of aquifer intercommunication between the confined and unconfined aquifers resulting from activities of the 200-East and 200-West Areas, was accomplished through collection and analysis of hydraulic head and chemical data. Concentrations of radionuclides in the Rattlesnake Ridge aquifer were compared to the radionuclides in the unconfined aquifer and to concentrations reported by Graham, Last and Fecht (1984). Hydraulic head data were compared to measurements by Jensen, Schatz and Liikala (1985) to determine the extent of any fluctuations in water level elevations from those of December 1985.

The study took place on the Hanford Site, which is located in south-central Washington State (see Figure 1). The study area was limited mainly to the B Pond - Gable Mountain Pond area. This area contains the only extensive well network completed in the Rattlesnake Ridge aquifer on the Hanford Site.

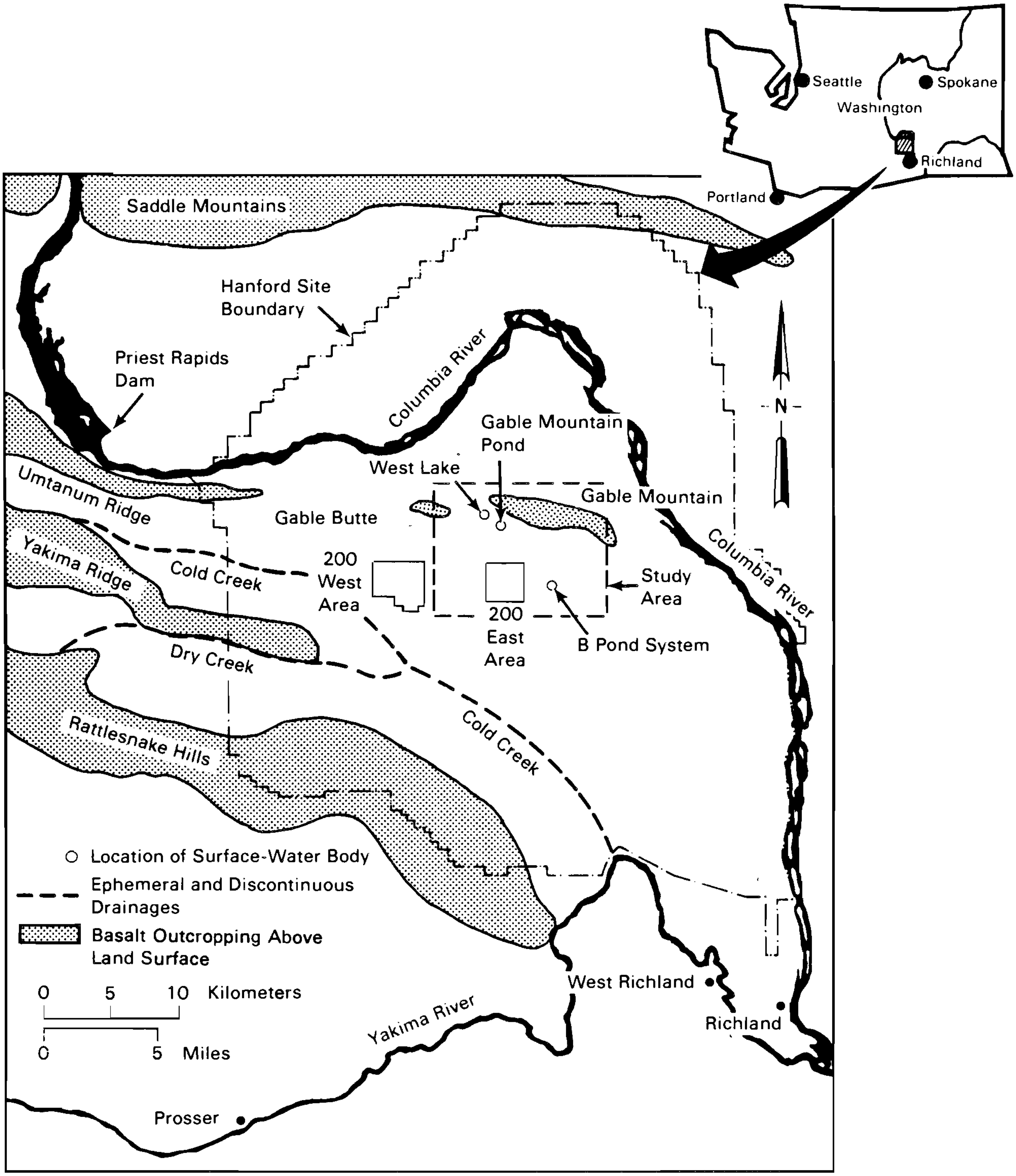


FIGURE 1. Map of Hanford Site Showing the Study Area

GEOLOGIC CHARACTERISTICS OF THE UNCONFINED AND CONFINED AQUIFERS

The unconfined aquifer is contained in the geologic units of the glaciofluvial sediments (informally called the Hanford formation) and the semiconsolidated silts, sands, and gravels of the Ringold Formation. The bottom of the unconfined aquifer throughout most of the study area is the top of the Elephant Mountain Basalt. In some areas the basal Ringold forms the bottom of the aquifer. In places where the Elephant Mountain Basalt is absent, other basalt flows or interbeds form the bottom of the aquifer (as reported by Myers/Price et al. 1979; Graham, Last and Fecht 1984; Fecht 1978; and others). The Rattlesnake Ridge aquifer occurs mainly within the Rattlesnake Ridge interbed. The top of the interbed is confined by the Elephant Mountain Basalt and the bottom is confined by the Pomona Basalt. Throughout this report the Rattlesnake Ridge aquifer will be referred to as the confined aquifer. A geologic description of each unit in the unconfined and confined aquifers follows (in descending order).

The Hanford formation consists of catastrophic flood sediments that were deposited when ice dams in western Montana and northern Idaho were breached and massive volumes of water spilled abruptly across what is now eastern and central Washington. Thick sequences of sediments were deposited across the Hanford Site by several episodes of Pleistocene flooding (Tallman et al. 1979).

In the central portion of the Hanford Site, the Ringold Formation has been divided into four units: 1) sand and gravel of the basal Ringold member; 2) clay, silt, and fine sand with minor gravel lenses of the lower Ringold member; 3) occasionally cemented sand and gravel of the middle Ringold member; and 4) silt and fine sand of the upper Ringold member (Brown 1959). These units pinch out laterally to the north and east, where the Ringold sediments consist of slackwater and over-bank deposits.

The Elephant Mountain Member of the Saddle Mountains Basalt consists of two basalt flows within the Pasco Basin (Elephant Mountain 1 and Elephant Mountain 2). A zone of sands and clays between these two basalt flows is referred to as the Elephant Mountain aquifer. The ground-water flow in this aquifer is believed to parallel that of the Rattlesnake Ridge aquifer, because the hydraulic head values of the two aquifers are approximately equal (Graham, Last and Fecht 1984).

The Elephant Mountain aquifer is in contact with the unconfined aquifer in the northeast corner of 200-East Area, where the Elephant Mountain 1 basalt flow is absent. Graham, Last and Fecht (1984) identified several areas where both of the Elephant Mountain flows are completely eroded (dotted areas in Figure 2). The Rattlesnake Ridge aquifer is exposed to the unconfined aquifer in these areas of erosion. The Elephant Mountain aquifer probably discharges to the unconfined aquifer, although it may be influenced locally by the groundwater mound under B Pond (Graham, Last and Fecht 1984).

The Rattlesnake Ridge interbed can be locally divided into four units. These are, in descending order: 1) a tuffite derived from reworking the volcanic ash unit, 2) a volcanic ash unit, 3) a fluvial-flood plain unit, and 4) a clay matrix-supported basaltic conglomerate formed by weathering and reworking of the Pomona flow top.[a] The lithologies of the Rattlesnake Ridge interbed control the movement of ground water within the confined aquifer. Its thickness ranges from 50 to 70 ft, and hydraulic conductivity ranges from 10 to 10^2 m/day (DOE 1982).

The Pomona Member of the Saddle Mountains Basalt consists of several dense basalt flows that are up to 200 ft thick in some locations. The fine-grained to glassy texture of the Pomona is characteristic throughout the study area (Myers and Price 1981).

The confined aquifer is recharged in the surrounding higher elevations by irrigation and rain (Graham, Last and Fecht 1984). Erosion of the Elephant Mountain Basalt and the Rattlesnake Ridge interbed in the vicinity of West Lake has allowed the Rattlesnake Ridge aquifer to discharge to the unconfined aquifer. The confined waters discharge to the unconfined aquifer where they eventually discharge to the Columbia River (Fecht 1978; Graham, Last and Fecht 1984).

(a) 1984 data from G. V. Last and K. R. Fecht of Rockwell Hanford Operations, Richland, Washington, as a result of their research of the ground-water geology of the intercommunication study area on the Hanford Site.

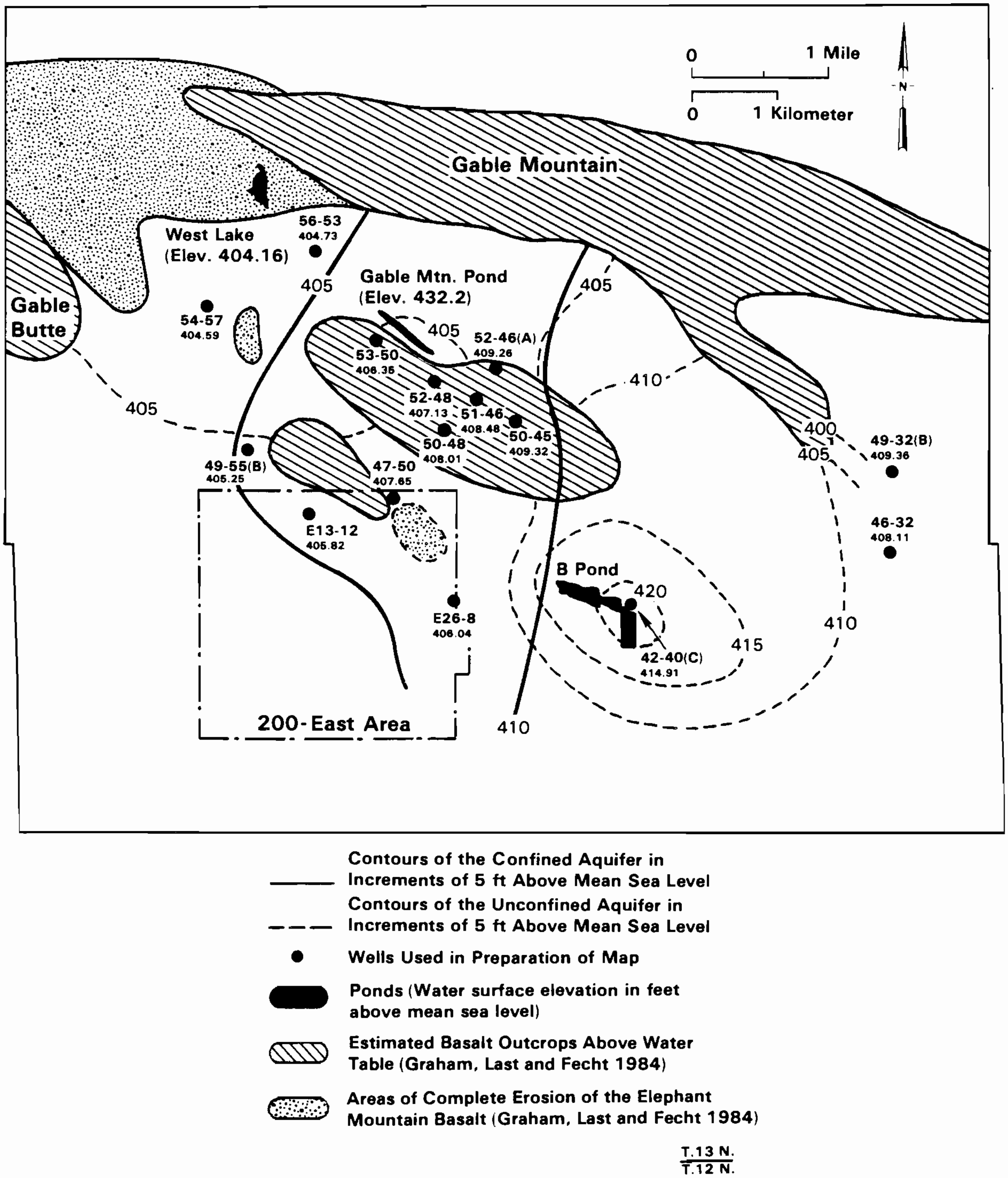


FIGURE 2. Potentiometric Surface Map of the Rattlesnake Ridge Confined Aquifer Within the Hanford Site, December 1986

HYDRAULIC HEAD MEASUREMENTS

Water levels were measured in the unconfined and Rattlesnake Ridge aquifers during December 1986 (see Appendix Tables A.1 and A.2) to determine the effects of water discharging to the ground from the 200-East and 200-West Areas in the B Pond - Gable Mountain Pond area. Figures 2 through 5 were drawn from these data and from data in Jensen, Schatz, and Liikala (1985).

The water table surface in the unconfined aquifer is illustrated in Figure 3, and the contours of the potentiometric surface of the Rattlesnake Ridge aquifer are compared with the water table surface of the unconfined aquifer in Figure 2.

Elevations in the unconfined aquifer from December 1985 to December 1986 are compared in Figure 4. In this figure, a minus sign means that the water table elevation has dropped since December 1985, and a plus sign means that it has risen. The elevation of the water table in the unconfined aquifer has decreased slightly in the southeast corner of the 200-East Area, around B Pond, and near Gable Mountain Pond during the past year (identified by minus signs in Figure 4). A slight increase was observed over the rest of the B Pond - Gable Mountain Pond area (identified by plus signs in Figure 4).

Changes in the potentiometric surface of the Rattlesnake Ridge aquifer from December 1985 to December 1986 are illustrated in Figure 5. A decrease in elevation of the potentiometric surface of the Rattlesnake Ridge aquifer has occurred around B Pond since December 1985. Water levels in wells 699-42-40C and 299-E26-8, completed in the confined aquifer, decreased by 0.41 and 0.38 ft, respectively. Well 699-42-40C is located downgradient of B Pond, and well 299-E26-8 is located on the east side of the 200-East Area, the same area where the largest decrease in water levels occurred in the unconfined aquifer (Figures 4 and 5). The potentiometric surface of the Rattlesnake Ridge aquifer rose in all other wells measured within the study area.

Wells 699-42-40A and 699-42-40B are completed in the unconfined aquifer, and well 699-42-40C is completed in the Rattlesnake Ridge aquifer (Figure 6). These wells are adjacent to each other and near B Pond. The hydrographs of wells 699-42-40A, B, C (Figure 7) illustrate the relationship between the

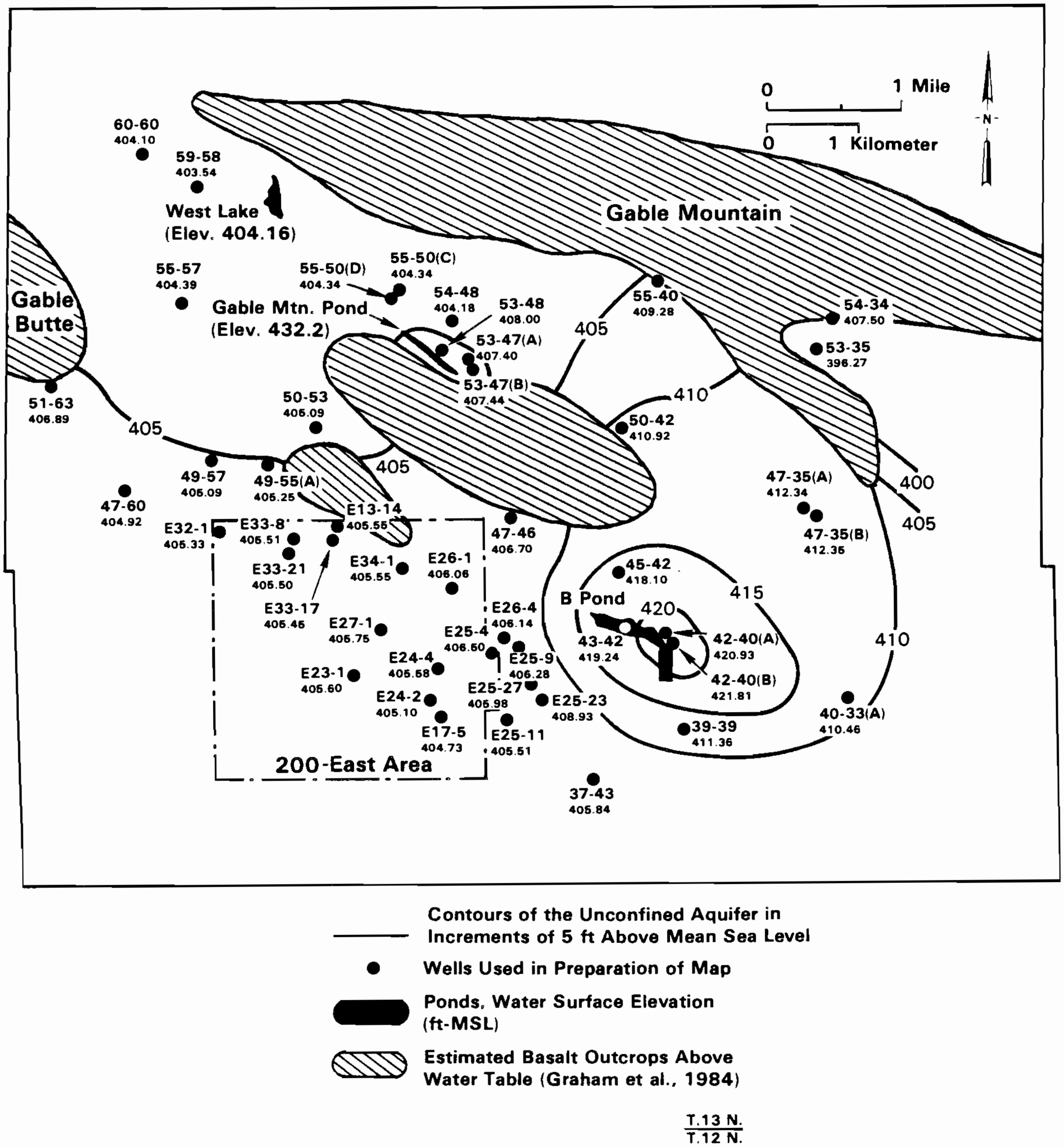


FIGURE 3. Water Table Map of the B Pond - Gable Mountain Pond Area at the Hanford Site, December 1986

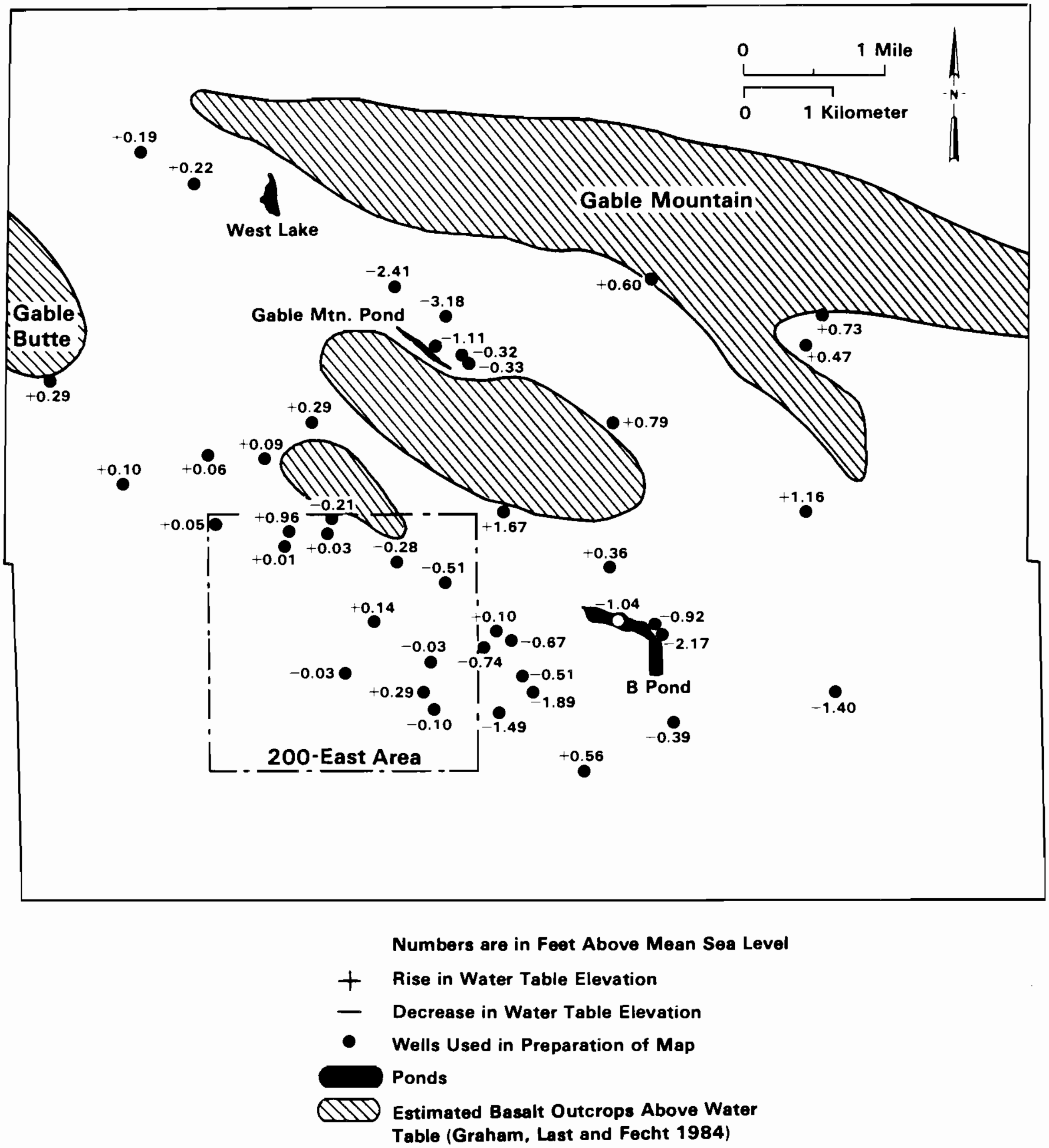


FIGURE 4. Changes in the Water Table Elevations from December 1985 to December 1986

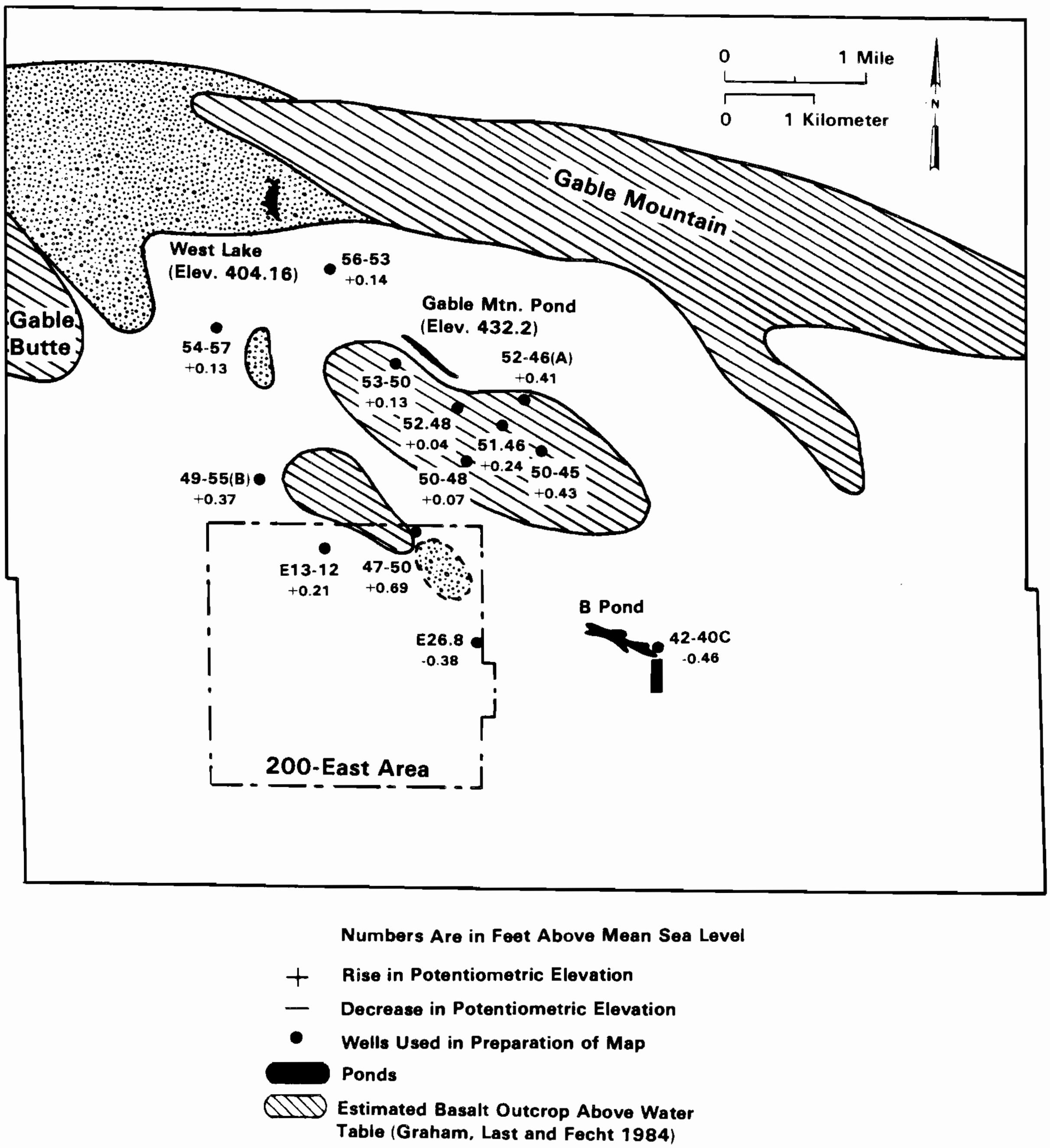


FIGURE 5. Changes in the Potentiometric Elevations from December 1985 to December 1986 in the Rattlesnake Ridge Aquifer

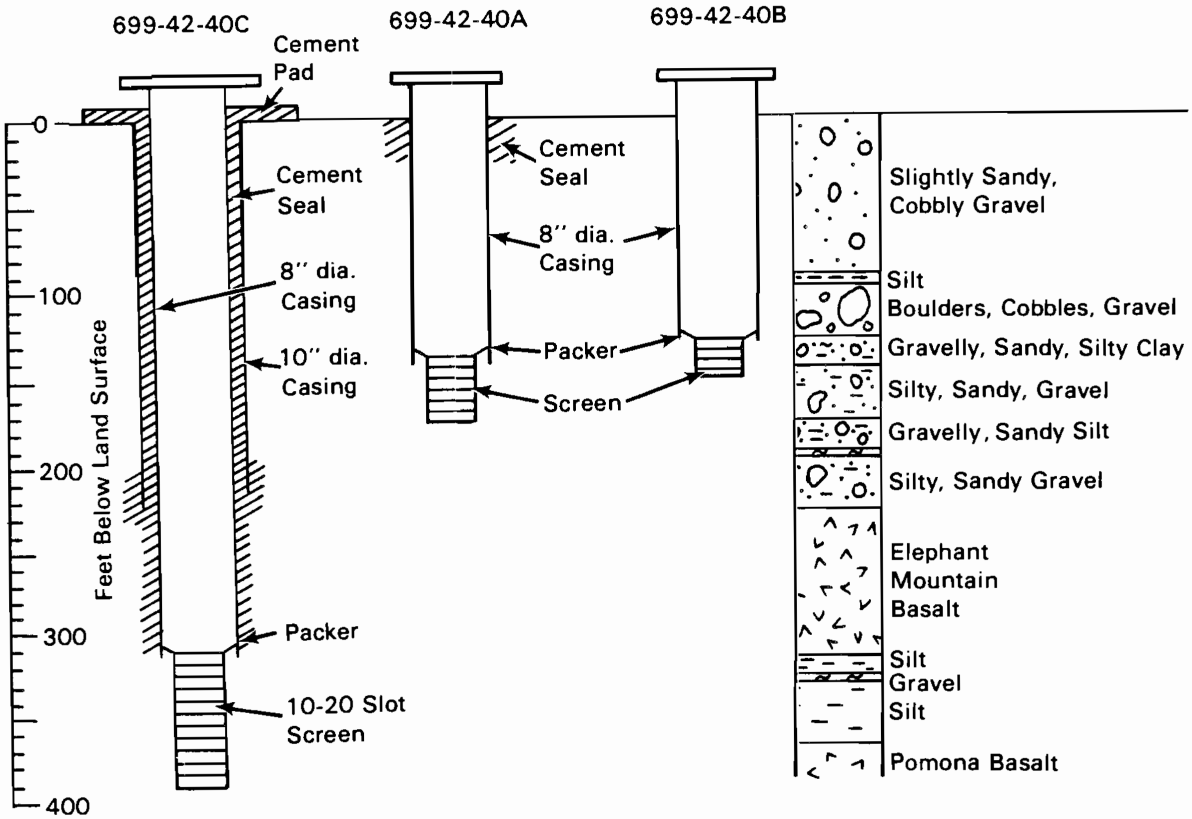


FIGURE 6. Construction Diagrams and Geology of Wells 699-42-20A, 699-42-40B, and 699-42-40C

hydraulic heads in the confined and unconfined aquifers.[a] Graham, Last and Fecht (1984) concluded that direct communication between the unconfined and Rattlesnake Ridge aquifers occurs as a result of erosional "windows" through the confining bed (Elephant Mountain Basalt). These areas of erosion were identified north and west of B Pond. Leakage between the aquifers may also occur through fractures in the Elephant Mountain Basalt. The water level fluctuations in the well completed in the Rattlesnake Ridge aquifer near B Pond (well 699-42-40C; Figure 7) appear to be the result of changes in leakage from the fluctuating B Pond mound in the unconfined aquifer (wells 699-42-40A and B;

(a) 1986 data from G. V. Last, M. A. Young, T. L. Liikala and E. J. Jensen of Pacific Northwest Laboratory, Richland, Washington, as a result of their research on the water level changes beneath the Separations Areas of the Hanford Site.

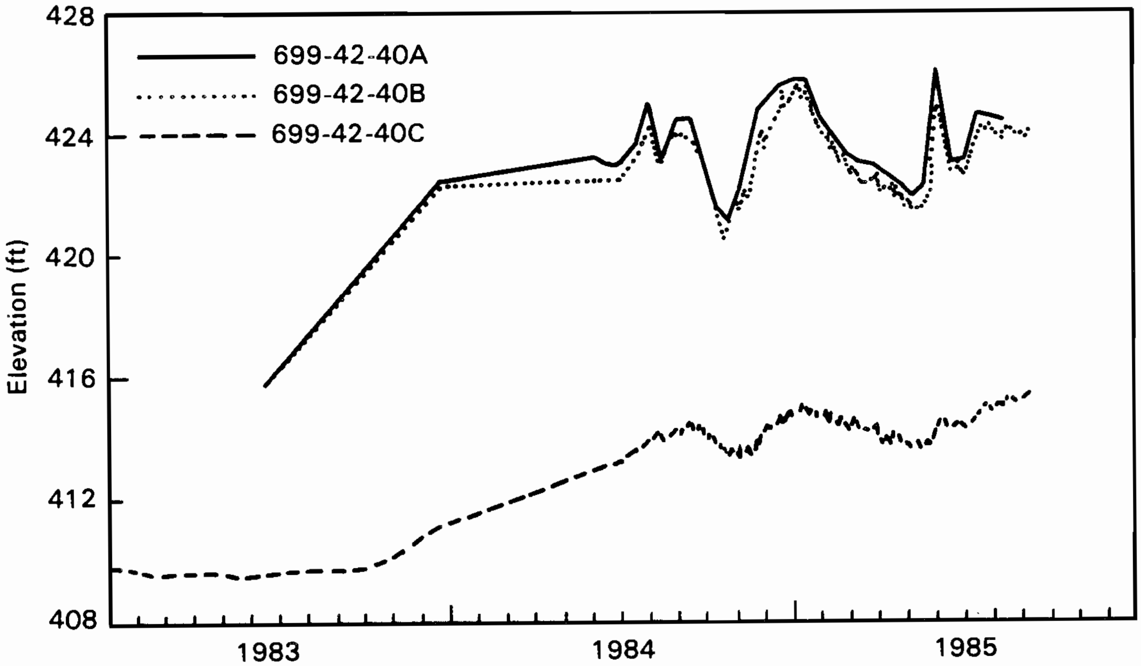


FIGURE 7. Hydrograph of Wells 699-42-40A, 699-42-40B, and 699-42-40C

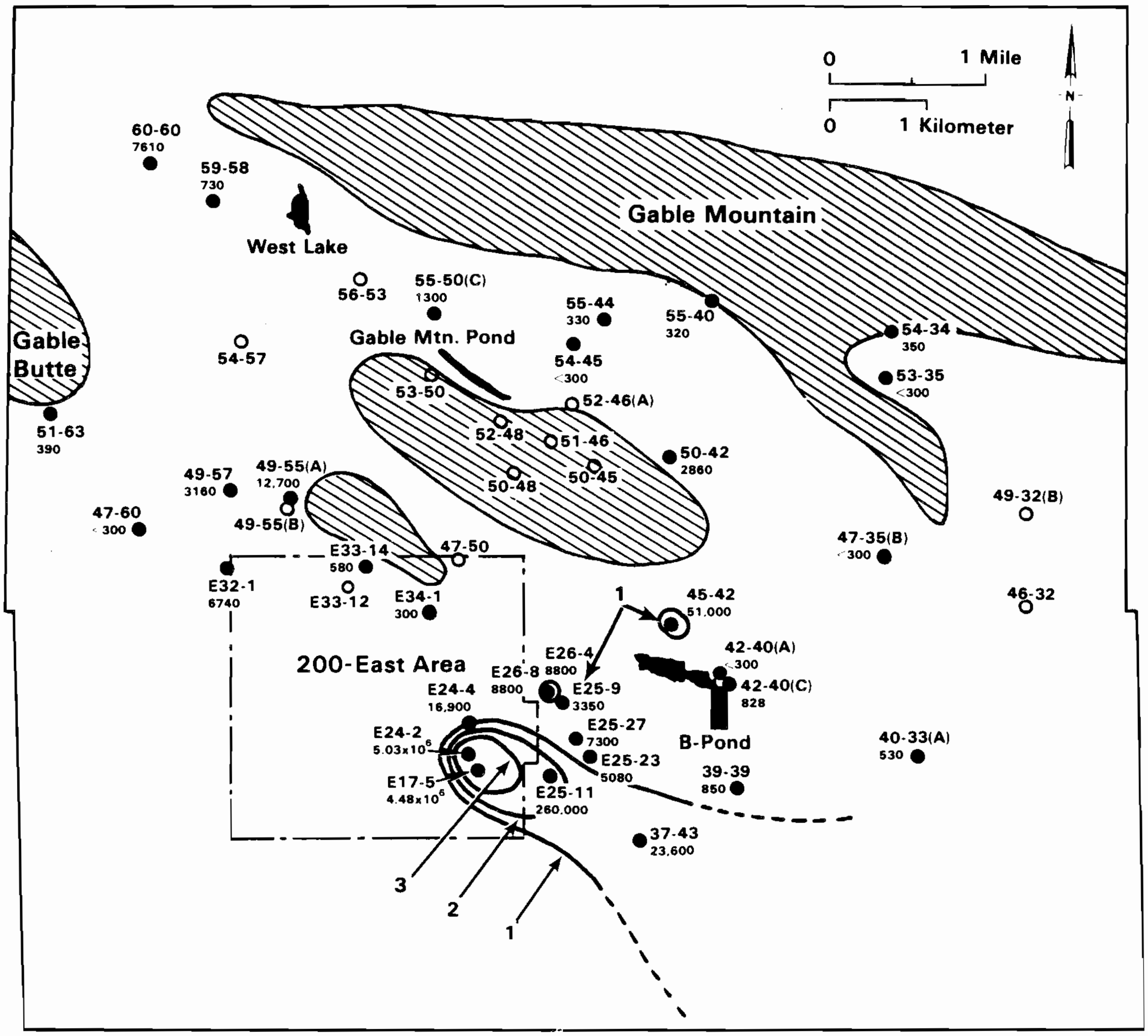
Figure 7). The higher frequency changes in the water table elevation (1 to 2 months) do not result in a response in the Rattlesnake Ridge aquifer, whereas the lower frequency changes (>2 months) are propagated to the confined aquifer. This dampening of response is a result of the vertical hydraulic conductivity and thickness of the confining bed.

Estimates of this leakage from the unconfined to the confined aquifer can be made with calibrated flow models. The flux through the bottom of the unconfined aquifer has not been considered in the ground-water models of the Hanford Site. This component of water balance could prove to be significant. Additional insight into leakage could be gained through stable isotope analyses of the ground waters.

CHEMICAL ANALYSIS

In addition to hydraulic head data, ground-water samples were collected from the Rattlesnake Ridge and unconfined aquifers. The samples from both aquifers were analyzed for tritium, nitrate, cobalt-60, cesium-137, and ruthenium-106 by U.S. Testing Company, Inc., Richland, Washington. Tritium, nitrate, and ruthenium were chosen for this study because their poor ion-exchange characteristics cause them to be more readily transported in the ground water than the other constituents; these ions move through the ground water at approximately the same rate as water, which makes them good tracers for ground-water movement. Cobalt and cesium were chosen because of their abundance in the separations areas' liquid waste, which is being discharged to the ground (Law and Schatz 1986). Their presence in the ground-water demonstrates a direct interaction between the ground water and the liquid wastes. However, these two constituents are poor tracers because they have good ion-exchange characteristics, which make them less mobile in the ground water (Prater et al. 1984).

The map in Figure 8 illustrates the average tritium concentrations in the unconfined aquifer from August to November 1986. The Rattlesnake Ridge aquifer was sampled during the week of September 8-14, 1986, using the wells and sampling devices listed in Table 1. The concentrations in pCi/L, given beside each well number in Figure 8, may be compared to data from the confined aquifer in Tables 2 through 7. All the wells listed in Table 1 are completed in the Rattlesnake Ridge aquifer, except well 699-S16-24, which is completed in the Mabton interbed. The Mabton interbed is located below the Pomona Basalt and has hydraulic properties very similar to the Rattlesnake Ridge interbed. Wells 299-E33-12 and 699-47-50, located near the northeast corner of the 200-East Area, contain small amounts of tritium and nitrate. Well 699-42-40C, near B Pond, contains an insignificant level of tritium, and no other contaminants were detected (Table 2). The remaining Rattlesnake Ridge wells were below detection limits for tritium, nitrate, cobalt-60, cesium-137, and ruthenium-106 (Tables 2 through 7).



1, 20,000 pCi/L;
2, 200,000 pCi/L;
3, 2,000,000 pCi/L

● Wells in the Unconfined Aquifer That Were Sampled for Tritium

○ Wells in the Rattlesnake Ridge Confined Aquifer

FIGURE 8. Unconfined Aquifer, Average Tritium Concentrations for August, September, October, and November 1986

TABLE 1. Wells Used to Sample the Rattlesnake Ridge Aquifer

Well Number	Depth to Water (ft)	Casing Diameter (in.)	Sampling Method	EMA Number (Well Code)
199-B3-2P	38.00	1.5	Bailer	1856
199-H4-2	0.00	2.0	Valve	1876
299-E26-08	197.00	8.0	Pump	2558
299-E33-12	216.91	6.0	Pump	2559
699-20-E5P	80.00	1.5	Air lift	4705
699-20-E5Q	99.00	1.5	Air lift	4706
699-22-70P	184.77	1.5	Bailer	4673
699-24-1P	88.00	1.5	Air lift	4710
699-42-40C	131.00	8.0	Pump	4912
699-46-32	60.00	6.0	Pump	4908
699-47-50	177.00	6.0	Pump	4913
699-49-32B	105.00	6.0	Pump	4909
699-49-55B	124.61	8.0	Pump	4910
699-50-45	43.00	6.0	Pump	4914
699-50-48	142.00	6.0	Pump	4883
699-51-46	36.00	8.0	Pump	4915
699-52-46A	47.00	8.0	Pump	4916
699-52-48	58.00	8.0	Pump	4917
699-53-50	38.00	8.0	Pump	4918
699-54-57	172.00	6.0	Pump	4919
699-56-53	30.00	8.0	Pump	4920
699-S16-24	132.04	2.0	Air lift	4911

TABLE 2. Tritium Concentrations in the Rattlesnake Ridge Aquifer

Well Number	Collection Date	Less Than[a]	Analysis Value
1-B3-2P	9/12/86		3.2500E+02
1-H4-2	9/10/86	<	-6.7600E+01
2-E26-8	9/08/86	<	-3.8500E+01
2-E33-12	9/11/86		3.9000E+02
6-20-E5AP	9/09/86	<	-1.3300E+02
6-20-E5AQ	9/09/86	<	-4.3900E+01
6-22-70P	9/12/86	<	-1.7200E+01
6-24-1P	9/09/86	<	2.8300E+01
6-42-40C	9/09/86		3.1300E+02
6-46-32	9/10/86	<	1.3200E+01
6-47-50	9/09/86		3.7200E+02
6-49-32B	9/10/86	<	6.0600E+01
6-49-55B	9/09/86	<	-2.4500E+02
6-50-45	9/10/86	<	-5.4600E+01
6-50-48B	9/09/86	<	-9.1300E+01
6-51-46	9/10/86	<	-6.6800E+01
6-52-46A	9/10/86	<	-6.0300E+01
6-52-48	9/10/86	<	4.0900E+01
6-53-50	9/11/86	<	-1.2900E+02
6-54-57	9/08/86	<	1.5900E+02
6-56-53	9/11/86	<	9.6900E+00
6-S16-24	9/12/86	<	3.2300E+00

(a) A "less than" sign (<) means that the magnitude of the analysis result is less than the counting error.

TABLE 3. Nitrate Concentrations in the Rattlesnake Ridge Aquifer

Well Number	Collection Date	Analysis Value
1-B3-2P	9/12/86	2.0000E-01
1-H4-2	9/10/86	4.1000E-01
2-E26-8	9/08/86	5.0000E-01
2-E33-12	9/11/86	4.9100E+00
6-20-E5AP	9/09/86	1.2700E+00
6-20-E5AQ	9/09/86	3.3000E-01
6-22-70P	9/12/86	2.0000E-01
6-24-1P	9/09/86	1.6000E-01
6-42-40C	9/09/86	3.3000E-01
6-46-32	9/10/86	6.7000E-01
6-47-50	9/09/86	5.6800E+00
6-49-32B	9/10/86	6.6000E-01
6-49-55B	9/09/86	7.5000E-01
6-50-45	9/10/86	5.0000E-01
6-50-48B	9/09/86	5.0000E-01
6-51-46	9/10/86	6.6000E-01
6-52-46A	9/10/86	1.4500E+00
6-52-48	9/10/86	1.6000E-01
6-53-50	9/11/86	3.3000E-01
6-54-57	9/08/86	1.1800E+00
6-56-53	9/11/86	6.6000E-01
6-S16-24	9/12/86	2.0000E-01

TABLE 4. Cobalt-60 Concentrations in the Rattlesnake Ridge Aquifer

Well Number	Collection Date	Less Than[a]	Analysis Value
1-B3-2P	9/12/86	<	3.0400E+00
1-H4-2	9/10/86		8.0200E+00
2-E26-8	9/08/86	<	-3.5000E+00
2-E33-12	9/11/86		1.9600E+01
6-20-E5AP	9/09/86	<	2.2500E+00
6-20-E5AQ	9/09/86	<	3.0300E+00
6-22-70P	9/12/86	<	2.2600E+00
6-24-1P	9/09/86	<	1.0700E+00
6-42-40C	9/09/86	<	-3.3400E+00
6-46-32	9/10/86	<	-1.2600E+01
6-47-50	9/09/86	<	4.0400E+00
6-49-32B	9/10/86	<	-4.6800E+00
6-49-55B	9/09/86	<	-6.2000E+00
6-50-45	9/10/86	<	-2.6700E+00
6-50-48B	9/09/86	<	2.0200E+00
6-51-46	9/10/86		7.8800E+00
6-52-46A	9/10/86	<	3.0300E+00
6-52-48	9/10/86	<	-4.6800E+00
6-53-50	9/11/86	<	-2.5200E+01
6-54-57	9/08/86	<	1.1300E+00
6-56-53	9/11/86		9.5900E+00
6-S16-24	9/12/86	<	3.2100E+00

(a) A "less than" sign (<) means that the magnitude of the analysis result is less than the counting error.

TABLE 5. Cesium-137 Concentrations in the Rattlesnake Ridge Aquifer

Well Number	Collection Date	Less Than[(a)]	Analysis Value
1-B3-2P	9/12/86	<	3.2000E-01
1-H4-2	9/10/86	<	-1.6500E+00
2-E26-8	9/08/86	<	-2.9900E+00
2-E33-12	9/11/86		7.2600E+00
6-20-E5AP	9/09/86	<	4.4700E+00
6-20-E5AQ	9/09/86	<	2.2400E+00
6-22-70P	9/12/86	<	-4.1300E+00
6-24-1P	9/09/86	<	-3.0000E+00
6-42-40C	9/09/86	<	-9.4800E+00
6-46-32	9/10/86	<	2.1400E+00
6-47-50	9/09/86	<	-3.1900E-01
6-49-32B	9/10/86	<	-7.8300E+00
6-49-55B	9/09/86	<	-5.1600E+00
6-50-45	9/10/86	<	-1.6600E+00
6-50-48B	9/09/86	<	3.5100E+00
6-51-46	9/10/86		3.4400E+00
6-52-46A	9/10/86	<	2.2400E+00
6-52-48	9/10/86	<	-4.1200E-01
6-53-50	9/11/86	<	-1.1100E+01
6-54-57	9/08/86		3.4400E+00
6-56-53	9/11/86	<	3.6600E+00
6-S16-24	9/12/86	<	1.3300E+00

(a) A "less than" sign (<) means that the magnitude of the analysis result is less than the counting error.

TABLE 6. Ruthenium-106 Concentrations in the Rattlesnake Ridge Aquifer

Well Number	Collection Date	Less Than[a]	Analysis Value
1-B3-2P	9/12/86	<	2.6700E+00
1-H4-2	9/10/86		1.0200E+10
2-E26-8	9/08/86	<	1.7800E+01
2-E33-12	9/11/86	<	-1.3800E+02
6-20-E5AP	9/09/86	<	-3.4500E+01
6-20-E5AQ	9/09/86	<	2.3800E+01
6-22-70P	9/12/86	<	2.6200E+01
6-24-1P	9/09/86	<	-5.8100E+01
6-42-40C	9/09/86	<	-3.0800E+01
6-46-32	9/10/86	<	-2.1300E+01
6-47-50	9/09/86	<	-2.3800E+01
6-49-32B	9/10/86		3.7500E+01
6-49-55B	9/09/86	<	-4.6000E+01
6-50-45	9/10/86	<	-2.2100E+01
6-50-48B	9/09/86	<	2.3800E+01
6-51-46	9/10/86		5.7400E+00
6-52-46A	9/10/86	<	-4.7500E+01
6-52-48	9/10/86		5.4600E+01
6-53-50	9/11/86		-4.6100E+01
6-54-57	9/08/86	<	1.4400E+01
6-56-53	9/11/86	<	-1.3800E+01
6-S16-24	9/12/86	<	-7.2700E+01

(a) A "less than" sign (<) means that the magnitude of the analysis is less than the counting error.

TABLE 7. Tritium Concentrations in Well 699-42-40C

Well Number	Collection Date	Less Than[a]	Analysis Value
6-42-40C	6/25/84		-7.4000E+01
6-42-40C	4/21/86	<	1.1300E+02
6-42-40C	9/09/86		3.1300E+02
6-42-40C	10/27/86	<	1.7000E+02

(a) A "less than" sign (<) means that the magnitude of the analysis is less than the counting error.

The tritium and nitrate in the confined aquifer at well 299-E33-12 are attributed to a high-salt, dense waste that migrated by density flow into the well when it was open to the unconfined aquifer (Graham, Last and Fecht 1984). This well has since been sealed from the unconfined aquifer by installing a liner in the well and grouting the annular space from the Elephant Mountain Basalt to the surface. This remedial action was taken by Rockwell Hanford Operations in 1982.

Well 699-47-50 is located near a postulated erosional window of the Elephant Mountain Basalt (Figure 2). The tritium and nitrate in this well have resulted from aquifer intercommunication (Graham, Last and Fecht 1984).

The tritium in well 699-42-40C appears to have increased since the well was drilled in 1982, but the analytical techniques used by Graham, Last and Fecht (1984) in 1982 were much more sensitive than those used in this study. Table 7 shows four samples analyzed by U.S. Testing Company, Inc. after 1982. Of these samples, only one has a tritium concentration that is slightly above the detection limit.

CONCLUSIONS

The elevation of the water table in the unconfined aquifer decreased slightly in the southeast corner of the 200-East Area, around B Pond, and near Gable Mountain Pond from December 1985 to December 1986. There was a slight increase in elevation of the water table over the rest of the B Pond - Gable Mountain Pond area during that time.

A decrease in elevation of the potentiometric surface of the Rattlesnake Ridge aquifer occurred around B Pond from December 1985 to December 1986. This surface rose in all other wells measured in the study area during that time.

Analysis of chemical constituents in the Rattlesnake Ridge aquifer demonstrates that communication between the unconfined and confined aquifers has occurred, although the levels of contaminants found in the Rattlesnake Ridge aquifer during this study are below DOE Derived Concentration Guides.[a] Because erosion of the Elephant Mountain Basalt and the Rattlesnake Ridge interbed near West Lake has allowed the Rattlesnake Ridge aquifer to discharge to the unconfined aquifer, these constituents will eventually discharge back to the unconfined aquifer in that vicinity (Graham, Last and Fecht 1984).

(a) Concentrations of radionuclides in water and air that could be continuously consumed or inhaled, respectively, and not exceed an effective dose equivalent of 100 mrem/yr (PNL 1987).

DATA UNCERTAINTIES

Some data uncertainties became apparent as this study progressed. These uncertainties are explained here to clarify the results obtained from this study. During this study it became apparent that several wells needed resurveying or new completion zones. These remedial actions would be used to better define the potentiometric surface and characteristics of the Rattlesnake Ridge aquifer near the 200-East Area.

The following wells need to be resurveyed: 699-54-45A, 699-54-49, 699-55-44, 699-46-32, and 699-49-32B. Wells 699-54-45A and 699-55-44 have water table elevations in the unconfined aquifer that are suspiciously low. Well 699-54-49, also completed in the unconfined aquifer, has never been surveyed. Accurate casing elevations of these wells are needed to obtain greater definition of the contours around Gable Mountain Pond. Wells 699-46-32 and 699-49-32B were drilled to the Pomona Basalt by Golder and Associates of Bellevue, Washington, in 1982 and left uncompleted. In August 1986, Pacific Northwest Laboratory (PNL) completed these two wells by installing a 20-slot screen over the entire thickness of the Rattlesnake Ridge aquifer. As a result, the casings have been moved to new elevations, so the old survey data may no longer be valid. If the casing elevations of these two wells are valid, then a flow boundary must exist somewhere between well 699-42-40C and well 699-46-32 (Figure 2). This would also change our concept of flow directions in the Rattlesnake Ridge aquifer to the east of B Pond. After this surveying is completed, more wells may need to be drilled or some old wells deepened to the east of B Pond to clarify this issue.

In September 1980, Rockwell Hanford Operations drilled well 699-54-45B. This well apparently was completed within the Elephant Mountain Basalt. The screen is set in 5 ft of basalt and 10 ft of clay. The static head is at 460 ft above mean sea level. The pieziometric surface of the Rattlesnake Ridge aquifer in this area is 410 ft above mean sea level. The short interval of clay around the screen in this well may be acting as a one-way valve by letting water go up the pipe column, but not letting it back down. To resolve this problem, the screen should be pulled and the well drilled through the Rattlesnake Ridge interbed to the Pomona Basalt with 4-in. casing. After the exact location of the stratigraphic layers has been determined, a screen can be installed across the entire length of the Rattlesnake Ridge aquifer. The proper completion of this well will give a better definition of the Rattlesnake Ridge aquifer. A similar type of reconstruction should also be considered for well 299-E16-1, which is completed in between the Elephant Mountain 1 and Elephant Mountain 2 basalt units.

Barometric efficiency and stable isotope studies of the wells completed in the confined aquifer may be useful in determining whether direct communication or local pressure changes are responsible for the fluctuations in elevation of the pieziometric surface. This could be accomplished by comparing data on barometric efficiencies and stable isotopes to those of Graham, Last and Fecht (1984).

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APPENDIX A

HANFORD WATER LEVEL MEASUREMENTS

TABLE A.1. Hanford Water Level Measurements in Unconfined Aquifer, December 1986

Well Number	Date	Depth to Water (ft)	Elevation to Water (ft)	Elevation of Casing
299-E17-05	12/18/86	313.92	404.73	718.65
299-E23-01	12/18/86	304.05	405.60	709.65
299-E24-02	12/18/86	312.09	405.10	717.19
299-E24-04	12/18/86	291.32	405.68	697.00
299-E25-04	12/17/86	252.79	406.60	659.39
299-E25-09	12/17/86	248.97	406.26	655.23
299-E25-10	12/17/86	250.22	404.78	655.00
299-E25-11	12/17/86	275.77	405.51	681.28
299-E25-23	12/17/86	271.26	408.93	680.19
299-E25-27	12/17/86	270.15	405.98	676.13
299-E26-01	12/18/86	211.19	406.06	617.25
299-E26-04	12/17/86	240.01	406.14	646.15
299-E27-01	12/18/86	275.30	405.75	681.05
299-E32-01	12/18/86	250.84	405.33	656.17
299-E33-08	12/18/86	245.52	405.51	651.03
299-E33-14	12/18/86	216.57	405.55	622.12
299-E33-17	12/18/86	226.20	405.45	631.65
299-E33-21	12/18/86	262.90	405.50	668.40
299-E34-01	12/18/86	223.87	405.55	629.42
699-37-43	12/17/86	284.33	405.84	690.17
699-39-39	12/17/86	125.29	411.36	536.65
699-40-33A	12/17/86	107.59	410.46	518.05
699-42-40A	12/12/86	124.50	420.93	545.43
699-42-40B	12/17/86	124.65	421.81	546.46
699-43-42	12/17/86	145.24	419.24	564.48
699-45-42	12/17/86	159.23	418.10	577.33
699-47-35A	12/17/86	64.01	412.35	476.36
699-47-35B	12/17/86	64.31	412.34	476.65
699-47-46	12/17/86	173.44	406.70	580.14

TABLE A.1. (contd)

Well Number	Date	Depth to Water (ft)	Elevation to Water (ft)	Elevation of Casing
699-47-60	12/17/86	244.92	404.92	649.84
699-49-55A	12/17/86	124.89	405.25	530.14
699-49-57	12/17/86	147.72	405.09	552.81
699-50-42	12/17/86	55.92	410.92	466.84
699-50-53	12/17/86	151.21	405.09	556.30
699-51-63	12/17/86	164.95	406.89	571.84
699-53-35	12/17/86	134.72	396.27	530.99
699-53-47A	12/17/86	30.88	407.40	438.28
699-53-47B	12/17/86	31.14	407.44	438.58
699-53-48A	01/15/87	36.45	406.00	442.45
699-54-34	12/17/86	142.74	407.50	550.24
699-54-45A	01/14/87	96.89	397.40	494.29
699-54-48	01/15/87	52.84	404.18	457.02
699-55-40	12/17/86	133.85	409.28	543.13
699-55-44	12/17/86	124.80	394.87	519.67
699-55-50A	01/15/87	38.42	404.39	442.81
699-55-50C	12/17/86	40.09	404.34	444.43
699-55-50C	01/15/87	40.25	404.18	444.43
699-55-50D	12/17/86	36.10	404.34	440.44
699-55-50D	01/15/87	36.25	404.19	440.44
699-55-57	12/17/86	162.27	404.39	566.66
699-59-58	12/17/86	94.23	403.54	497.77
699-60-60	12/17/86	107.93	404.10	512.03

TABLE A.2. Hanford Water Level Measurements in the Rattlesnake Ridge Aquifer, December 1986

Well Number	Date	Depth to Water (ft)	Elevation to Water (ft)	Elevation of Casing
299-E26-08	12/17/86	196.62	406.04	602.76
299-E33-12	12/18/86	217.18	405.82	623.00
699-22-70P	12/18/86	184.68	430.28	614.96
699-42-40C	12/17/86	131.25	414.91	546.16
699-46-32	12/17/86	62.09	408.11	470.20
699-47-50	12/17/86	176.22	407.65	583.87
699-49-32B	12/17/86	106.19	409.36	515.55
699-49-55B	12/17/86	125.08	405.25	530.33
699-50-45	12/17/86	42.09	409.32	451.41
599-50-48	12/17/86	142.38	408.01	550.39
699-51-46	12/17/86	36.15	408.48	444.63
699-52-46A	12/17/86	46.35	409.26	455.61
699-52-46A	01/15/87	46.49	409.12	455.61
699-52-48	12/17/86	58.89	407.13	466.02
699-53-50	12/17/86	37.86	406.35	444.21
699-54-45B	12/17/86	33.09	459.85	492.94
699-54-45B	01/14/87	33.16	459.78	492.94
699-54-57	12/17/86	170.99	404.59	575.58
699-56-63	12/17/86	29.61	404.73	434.34

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